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ART. XIV.—*An Address in Commemoration of Professor J. W. Bailey, late President of the American Association for the Advancement of Science;* by Dr. A. A. GOULD.

[Delivered before the Association, August 19, 1857.]

Mr. President and Gentlemen of the American Association for the Advancement of Science—We are called upon, at this time, to advert to an event such as has not before occurred in the history of this Association during the seventeen years since its inception. He who was elected at our last session to preside at this meeting, has in the mean time been taken from us. He, whom we all delighted to honor, though he sought not public honors from men, and who required no higher stimulus to his ambition nor reward of his toil than the satisfaction derived from the discovery and elucidation of the works and laws of Nature's God, has left this arena of trial and doubt to meet that God; and in his presence, where faith is turned to sight, we may well believe that he is unfolding with delight, unmingled with doubt, those wonderful works and perfectly harmonious laws which so engaged and delighted him on earth.

It is becoming that we should bestow a few moments in commemoration of his life and labors. There are others, who knew him much better, and were more conversant with his special studies than myself, to whom this office properly belonged; but as in another connection I had gathered some of the items of his history, and had noted the results of his scientific investigations, I have been requested to present them on this occasion.

JACOB WHITMAN BAILEY was born April 29, 1811, in the old town of Ward, Mass. (now Auburn), at the residence of his grandfather, Rev. Isaac Bailey, the first minister of that town. In infancy he was removed to Providence, and there received his early education in the ordinary schools of that day. The limited resources of his family rendered it necessary that he should early engage in some employment; and, at the age of twelve years he was placed at a Circulating Library, where he attracted the attention of visitors by his studious devotion to books. At this time also he began a collection of shells and insects. During a visit of the West Point cadets at Providence, he became acquainted with some of the officers, and then decided to seek admittance to the Military Academy. He received an appointment as cadet in July, 1828, and graduated July, 1832. He was appointed second lieutenant in the Artillery, April, 1833, and was promoted to first lieutenant, February, 1837. During this time he was stationed at Old Point Comfort, Bellona Arsenal, and Fort Moultrie. But with the development of his scientific tastes, military life had few attractions for him; and in 1839 he received the more congenial appointment of Professor of Chemistry, Mineralogy and Geology in the United States Military Academy, which appointment he held, first as assistant, and soon afterwards as principal, until his death. He was married in 1835, and, with his wife and only daughter, then seventeen years of age, was on board the steamer Henry Clay which took fire on the Hudson river, July 28, 1852. After having lowered them succesfully to the water, and received from them the assurance of their safety, he proceeded to follow, when suddenly a volume of smoke and flame veiled them from his view, and they were lost. He had previously been subject to a bronchial affection and occasional spitting of blood, for which he had resorted to Florida the previous winter with decided benefit. But the exertion and exposure on this occasion, together with the intensity of his bereavement, gave him a shock, from which he never rallied. With the exception of an occasional resort to the sea-shore during vacations, he was afterwards obliged to exclude himself almost entirely from society. His health steadily declined; and, feeling the certainty of the issue, he employed his leisure in arranging his papers, his microscopical collections, and his Algæ, so that they might be practically available to his successors. He died on the 27th of February last, at the age of forty-six.

As a man, he was remarkably unobtrusive and modest, gentle in his manners, truthful in his character, cordially beloved by all who had the good fortune to enjoy his acquaintance.

But it is more with his scientific position that we are concerned. His taste for science was very early developed. Begin-

ning with botany and mineralogy, and passing from these to geology, chemistry, and microscopy, he traversed a large portion of the field of natural science. In the departments more especially relating to his position at West Point, he held a high rank, and his publications show that he introduced many improvements in chemical manipulation. His correspondence, too, shows that he was extensively consulted by men of science on some of the most difficult points of analysis and general physics. His observations were always of the most careful and accurate character; and he early began the important practice of making notes of them, accompanied by delineations, leaving nothing to recollection or mere indefinite statements; thus having always at hand permanent data for his subsequent papers. The volume containing these, which he denominated "Microscopic Sketches," is, of itself, a surprising evidence of his industry and skill. There are four hundred and fifty sheets, containing about three thousand sketches. By his great skill with the pencil he rendered himself independent of artists, an accomplishment, for the lack of which, many of the best observers lose their labors. These drawings date back as far as 1838. twenty years ago, and enable us to trace out the course of his studies, as well as his wanderings; for wherever he went, his microscope or his collecting bottles went with him. At first, we have mostly sketches of vegetable and animal tissues, and occasionally an entire animal or plant. In January, 1839, while examining some aquatic plants, he perceived a curious object, a Gomphonema as it subsequently proved, which he did not understand. This excited his attention in that direction, and soon we find many others of the more common Diatoms delineated. In March, 1839, he sketched a new one, to which Ehrenberg gave the complimentary name *Stauronema Baileyi;* and finally he devoted himself with great zeal to the varied objects included under the general term Infusoria, and also to a department almost equally demanding his skill as a microscopist, namely, the Algæ. So far as the Infusoria were concerned, he stated, in 1843, that no one else in this country had studied them; and that it was almost impossible to procure any works relating to them. Ehrenberg's work he had not seen, though he modestly utters the thought that Ehrenberg might sometime see and correct his paper. He, however, gradually possessed himself of all the important works on those subjects, and became the active correspondent of Ehrenberg, Kützsing, Agardh, Quekett, Ralfs, Harvey, Greville, De Brébisson, Montagne, and very many others. Fossil deposits, mud, and guano, were collected from every quarter for investigation. The various exploring expeditions were laid under contribution: and more recently, the objects brought up on the sounding lead in the Coast Survey, and by Lieut. Berryman's line of soundings

across the Atlantic, made in reference to the laying of the telegraphic cable, occupied his attention. In pursuing these examinations, he found the relics from the bottom so well characterized in certain localities and at certain depths, that he suggested the possibility of being able, in some instances at least, to determine the safety or otherwise of a vessel, by an examination of the organisms brought up on the sounding lead, when prevented by darkness, snows or fogs, from deciding by ordinary observations.

Not a little of the obligation of microscopists to Prof. Bailey is due for his labors to improve the microscope. At any rate, few among us have ventured upon the purchase of a valuable instrument, without first consulting him in reference to it, and perhaps taxing him with unwelcome negotiations; and his letters show that numerous applications of this kind must have been a most serious tax upon his time. It is said that his own early observations were made with globules of glass blown by himself. After he became possessed of a proper instrument, many modifications in the construction of the stage and its movements, and in other appendages, were made by him; and it is to his experience and scientific deductions, coupled with the genius and incomparable optical skill of Spencer, that we are indebted for the most powerful microscopes that have yet been made. His masterly and triumphant defense of them against the detractions of transatlantic pens, also exhibits his complete mastery of the subject. One of his last essays was to construct an Indicator, by means of which the place of any object on a slide might readily and certainly be found. No one, in looking at the card, would credit the labor and thought which he, in conjunction with his friends, Judge Johnson and Mr. Gavitt, bestowed upon it. Many futile efforts were made, and many quires were used in correspondence, before the accuracy of its measurements, and a method for the unerring application of it, were satisfactorily accomplished.

At a very early date, Prof. Bailey began to publish the results of his observations,—a duty too often neglected by scientific men. His published papers are very numerous,—more than fifty,—extending as far back as 1837, and up to his very last hours. They were, for the most part, very brief, free from ostentation, aiming to communicate facts in the simplest and most direct manner. In the words of his friend, Prof. Gray, "they are all clear, explicit, and unpretending as they are thorough; and every one of them embodies some direct and positive contribution to science." Most of them were terminated by a condensed statement of the general facts elicited, so as to show, at a glance, the subject and result arrived at. They are mostly to be found in Silliman's Journal of Science, or in the Smithsonian

Contributions to Knowledge, except one in the first volume of the Transactions of the Association of Geologists and Naturalists, which embodied his previous papers on the Infusoria of the United States, with additions, and which gave him at once a high position as a scientific naturalist.

His Microscopical Collection will constitute his most splendid monument. The slides, of which there are five hundred and fifty, are arranged in boxes in the form of octavos, of which there are twenty-four volumes. More than three thousand objects, fixed upon slides, are catalogued and noted with reference to Bailey's Indicator, thus enabling any one readily to find with certainty the identical specimens described by him. There are also very many other slides not included in the regular collection. Being objects either described by himself or given to him by other describers, this collection must always possess the highest authority, and must be our ultimate reference in all cases of doubt.

The collection of Algæ is equally complete and authentic. It consists of thirty-two portfolios, containing about 4,500 specimens; and it may safely be said that few collections in the world are superior to it.

It is probably well known that Prof. Bailey bequeathed his Microscopical Collection, his Collection of Algæ, his books on Botany and Microscopy, his Memoranda and his Scientific Correspondence, to the Boston Society of Natural History. While the Society intends to keep this bequest sacredly, it means also to make it as extensively useful as possible. I hesitate not, in behalf of the Society, to invite all who are pursuing similar researches to consult these collections, whenever convenient,—and to give assurance also, that any questions which may be solved by it may be freely addressed to the Society. A large collection of rough material for microscopic research, from many of the most interesting localities, is also in the possession of the Society, and will be distributed to microscopists and societies.

Such are some of the principal events in the history of our distinguished associate and President, and such are some of the accumulated fruits of his scientific labors,—labors which were performed in addition to the full duties of a professorship, executed with military precision and punctuality. He has won for himself a place by the side of the most eminent microscopists and algologists of the old world, and may well be styled the Ehrenberg of America. He will always stand, in this country, as the father of those branches of Natural History which relate to the *world of atoms*, and must for ever remain the standard reference here in relation to them. Let no man think lightly of them because they relate to little things, too small to be discerned by the unassisted eye. Are they not equally the handi-

work of him who made and sped the spheres, and formed man in his own image? And if he, by the microscope, demonstrated the vegetable structure of coal, illustrated the lowest habitable depths of the ocean, settled the nature of some of the important geological strata, and of the vast deserts otherwise deficient in geological indications,—questions of practical importance in our investigations of the crust of the earth,—let him receive a corresponding rank with him who points the telescope to the mighty orbs above, determines their magnitudes and movements by scientific induction, and thereby enables us to determine our place upon that crust.

I cannot refrain from quoting, in conclusion, the words of an intimate friend in a letter to him, on learning of his appointment as President for this meeting. He says, "I am sure every one acquainted with what you have done for the advancement of science, American science, and American scientific character, will say, that no appointment, at the present time, could be more appropriate or just. I hope the great Disposer of events, whose minute works you have done so much to place before our eyes in all their exquisite beauty of form, of workmanship, and of adaptation, will give you yet many years to enjoy the honors you have so honestly acquired, and to add many more discoveries to those you have already secured." And may I not respond for you all, Would that this desire had been granted!

ART. XV.—*On some remains of Batrachian Reptiles discovered in the Coal Formation of Ohio, by Dr. J. S. Newberry and Mr. C. M. Wheatley;** by JEFFRIES WYMAN, M.D., of Cambridge, Mass.

ONE of the most interesting subjects presented to the palæontologist for investigation, is that relating to the determination of the period when the Creator gave forms to organized beings, and placed them in definite relations with the earth and its atmosphere, and made them living things. But the history of geology shows, that generalizations as to the time and circumstances of the creation of given animal forms have approached precision only, as the depths of the ancient lakes and oceans have been faithfully explored, and the shores and dry lands which coëxisted with them have been accurately explored.

It was during the deposition of the Oolite that reptilian life reached its culminating point; below this, the deeper explorations are carried, the less numerous are the remains of reptiles found to be, and it has been assumed within a few years even,

* A short verbal account of these fossils was given to the Am. Assoc. for the Advancement of Science at their meeting in Albany, in 1856.

that their creation took place during the triassic period. The coal formations had been largely examined, thousands of fishes and still lower animals had been discovered, before the first traces of reptiles came to light in the remains of Apateon and Archegosaurus. After these, there were found the footprints and other remains of other reptiles, discovered or described by Goldfuss,* Burmeister,† Dr. King,‡ Sir Charles Lyell,§ Mr. Lea,‖ Herman Von Meyer,¶ Profs. Dawson,** Owen,†† H. D. Rogers‡‡ and E. Hitchcock.§§ The Telerpeton, discovered by Dr. Mantell, was obtained from the upper layers of the Elgin sandstones; and these some of the leading English geologists have referred to the Old-red. Doubts have recently arisen as to their real age, so that, in the present state of knowledge we cannot refer reptile life to a period older than the Coal. However, in view of our as yet imperfect knowledge of the Old-red fauna, the question may still be raised whether we have even now reached the period of primoidal reptiles.

The remains described in this paper are important additions to the proofs of the presence of reptilian life during the Carboniferous epoch, showing the existence of at least three species and

* Beiträge zur vorweltlichen Fauna des Stein-kohlengebirge. Bonn, 1847, 4to. Also in Leonhard and Bronn Jarhbuch, 1847, p. 400.

† Die Labyrinthodonten aus dem saarbrucker Stein-kohlengebirge, Pt. III, Archegosaurus, Berlin, 1850.

‡ Description of fossil footmarks (of *Thenaropus heterodactylum*) found in the Carboniferous series, in Westmoreland Co., Penn., by Alfred T. King, M.D., Am. Journal of Science, vol. xlviii. p. 343, and in vol. i, new series, p. 268.

§ On the evidence of fossil footmarks of a quadruped allied to Cheirotherium in the Coal strata of Pennsylvania, by Charles Lyell, Esq., F.R.S., &c., Am. Journal of Science, vol. ii, new series, p. 25.

Also on the remains of a reptile, (*Dendrerpeton Acadianum*, Wyman and Owen,) and of a land shell discovered in the interior of an erect fossil tree, in the coal measures of Nova Scotia, by Sir Charles Lyell, F.R.S., &c., and J. W. Dawson, Esq. Quarterly Journ. of the Geol. Soc., London, May 1853, vol. ix, p. 58.

‖ On Reptilian footmarks in the gorge of the Sharp Mountain near Pottsville, Penn., by Isaac Lea, Esq. Proceedings of the Am. Phil. Soc., 1849, p. 91; also in the Am. Journ. of Science, vol. ix, new series, 1850, p. 124. And Trans. Am. Phil. Society, vol. x, Art. xxi, p. 308; and in his splendid mongraph, grand folio, 1855.

¶ H. de Von Meyer. Palæontographica I, p. 112. The reptilian nature of Archegosaurus has been disputed, but the investigations of Von Meyer based upon an examination of the remains of a great number of individuals belonging to two species, have shown that in addition to double occipital condyles, this animal possessed well developed arms and legs, which are sufficient to establish its reptilian nature.

** Notice of a Reptilian in the Coal of Pictou, by J. W. Dawson, Esq., F.G.S., Journal of Geol. Soc., London, vol. xi, p. 8. Nov. 1854.

†† Notice of a Batrachoid fossil, (*Parabatrachus Colei*) in British Coal shale, by Prof. Owen, F.R.S., &c., Quart. Journ. of Geol. Soc., London, vol. x, p. 207, Dec., 1853. This was first recognised by Prof. McCoy in the Museum of the Earl Enniskiller, also,

Baphetes planiceps, a fossil imbedded in a mass of Pictou Coal from Nova Scotia, by Prof. Owen, F.R.S., &c., Quart. Journ. Geol. Soc., of London, vol. x, p. 207, 1853.

‡‡ Reports on the Geol. Survey, Pennsylvania, not yet published.

§§ Memoirs of Am. Acad. of Arts and Sciences, vol. iii, new series, p. 129.

two genera, not hitherto noticed. Two of the species were discovered by Dr. J. S. Newberry of Ohio, and a third by Mr. C. M. Wheatley of New York, who have entrusted them to me for description.

Raniceps Lyellii.—This was found by Dr. Newberry in company with many other remains, for the most part of fishes, and was regarded by him as Batrachian. He gives the following description of their geological position. "The locality which furnishes the fossil fishes and reptiles is at Linton, Jefferson Co., Ohio, on the property of the Ohio Diamond Coal Co., at the mouth of Yellow Creek. This point is about fifty miles distant from the northwest margin of the Alleghany coal-field, and therefore about as near the centre of the basin as any part of Ohio. The hills bordering the Ohio at the mouth of the Yellow Creek, contain six workable beds of coal, while there are at least two others which lie beneath the bed of the river. Of those exposed, the fourth in the ascending series contains the fishes and reptiles; it is known on Yellow Creek as the "big run" being nearly eight feet in thickness. Of this thickness, the lower four inches is of Cannel coal, and this forms the nidus of our fossils. The "big run" I have traced over several hundred square miles, and there can be no doubt of its position. The animal remains of this deposit lie in immediate proximity to the most characteristic carboniferous plants and shells." Dr. Newberry also gives a section of the different strata, which lie in the following order from above downwards. 1. Shale and sandstone; 2. *coal;* 3. shale and fire-clay; 4. sandstone and shale; 5. *coal;* 6. shale and clay; 7. sand-rock; 8. shale; 9. *coal* with reptilian and fish remains; below this, ten additional strata are mentioned, including three of *coal.* "Geographically, as well as stratigraphically, these fossils come from near the centre of the basin."

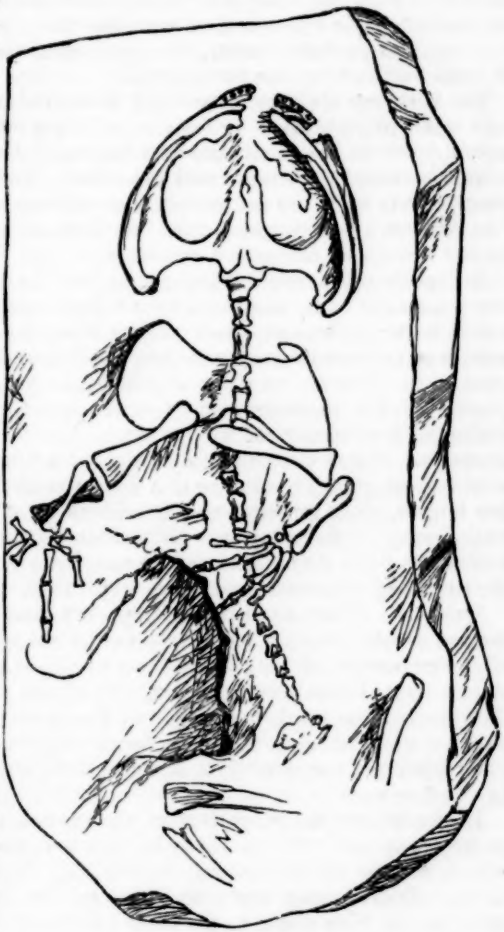
The skeleton (fig. 1,) was exposed on splitting open two laminæ of matrix, and in the act of separation, the tail (if it had one), some of the dorsal vertebræ, and a portion of the pelvis were destroyed. As is usually the case with fossils from the coal, all the bones were very much obscured by compression and by their intimate union with the substance in which they are imbedded. They are seen from the underside and measure about four and one-half inches in length.

The Batrachian characters are strongly marked, and were recognized by Dr. Newberry; yet they do not strictly conform with either one of the two great groups, but rather combine the features of the Urodel and Anourous types; the first predominating in the trunk and extremities, and the latter in the head.

The general form of the head resembles that of frogs; it is triangular, and its greatest breadth nearly equals its length. Existing Urodels are characterised by having the lower jaws either

shorter than the cranium, so that the tympanic bones to which these are articulated are directed obliquely forwards; or as in Menopoma where the jaws are longer, they are directed outwards; in toads, the jaws are as long as the cranium, but in the Ranidæ are decidedly longer and project backwards beyond the occiput, as is also the case with the fossil. In both toads and frogs, the angles of the jaws are slightly concave on their outer surface, but in the fossil no such curve exists, the whole outer border of the jaw being convex as in Urodels generally. The pterygoid bones are less expanded than in Urodels but more so than in Anoura. The dentar bone appears to be closely united with the one behind it, as in Urodels generally and in Pipa among Anoura. The position of the jaw prevents the alveolar margin from being seen; therefore it is impossible to determine either the presence or absence of teeth.

1.



Raniceps Lyellii.

The upper jaws are but imperfectly uncovered, especially on the right side; the two are slightly separated from each other

and are provided with small single pointed teeth. That on the left side is sufficiently exposed to show that it is bifurcated towards the median line, as in Anoura.

The palatine bones could not be traced. The atlas is in close apposition with the occiput so that the articulating surfaces are not visible. The expansion of the atlas indicates however, that two condyles probably exist. No portions of the hyoid bone or of branchial arches were recognized.

The vertebræ are very imperfectly preserved, and are remarkably small in proportion to the size of the animal, and though several of them are destroyed, it is estimated that about twenty existed between the occiput and the pelvis. The transverse processes, if any exist are not visible, nor is there evidence of ribs. The Anoura are destitute of ribs, but these are replaced by very largely developed transverse processes.

A slightly raised outline appears to be the only thing to indicate a scapular arch, but there are no details of structure. The arm is better preserved, the humerus is much contracted in the middle as in Batrachians generally; the radius and ulna are separate as in Urodels, and not united as in Anoura. In consequence of the displacement or concealment of some of the phalanges the number of fingers could not be ascertained with precision. There were certainly four, but a fifth is doubtful. It would be of great importance if a fossil should be detected with five fingers, since no existing Batrachians have more than four, while many of the supposed Batrachian footprints of the coal formations have five. The pelvis was destroyed, but traces of the right and left femur and of the right tibia remain.

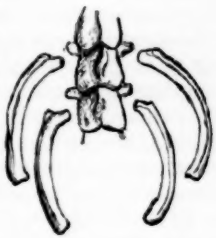
From the above description it appears that this, one of the earliest created reptiles, combines in the same individual some of the characters of both of the two principal groups of Batrachians, viz: Urodels and Anoura. It agrees with the latter in the shape of the head, the length of the lower jaws, and in the absence of ribs; and with the former in the regular convex outer border of the lower jaw, and in the separation of the bones of the fore arm.

If the anatomical characters of the species just described are in any way remarkable, those of the two closely allied ones which remain to be noticed deviate still farther from known forms. One of them was discovered by Mr. Wheatley and the other by Dr. Newberry, in the same locality as the fossil already mentioned in the preceding pages. In both instances about twelve or fifteen dorsal vertebræ and the corresponding ribs are the only parts of the skeleton which are preserved; but as there are only very slight differences in the successive vertebræ and ribs in each specimen, it is probable that several additional ones were necessary to complete the series, and this would indicate

that the animal had a very long and slender body. There are no traces whatever of limbs, head or tail, in either case.

The specimen, of which a small portion is represented in the accompanying figure (fig. 2, seen from above) is about two and a half inches long. There are in all thirteen or fourteen vertebræ with their ribs, these last being but very slightly displaced. The arches of all but three of the vertebræ are broken. The entire vertebra has a quadrangular form, is a little broader behind than in front, is surmounted by a spinous process forming a longitudinal ridge, on each side of which posteriorly, are two rather large lobes forming the articulating processes which overlap the succeeding bone. The transverse processes are well preserved throughout nearly the whole length of the specimen, and are situated near the anterior extremity of each vertebra, just exterior to the posterior border of the articulating processes.

2.



The ribs, well developed throughout, are remarkably well preserved; each has a short head, and behind this, a well marked tubercle, showing two points of articulation, and consequently warranting the inference that the transverse processes had likewise two articular facets, though these are not apparent in the fossil. The shaft of the rib is very much curved, flattened and impressed with a deep groove along its whole length near the convex border. The sternal portion of the rib is broader than the centre, as if for the attachment of a cartilage.

The general form of the vertebræ presents closer resemblances to those of Batrachians than of any other vertebrates, but the well developed ribs differ very materially from those of any known Batrachians, viz: in their great length, and the curvature,—in which respect they resemble those of scaly reptiles. The very existence of ribs separates them from the Anoura, and their length from Urodels; for the first have no ribs and the second only very short, and for the most part pointed ones.

If further investigation should prove them to be the remains of Batrachians, with which they have some affinities, then we shall have a type of which there is no living representative. If they belong to a group higher in the series, they become still more interesting, and give evidence of the existence in the Coal Formation of animals hitherto referred to later periods.

The third specimen consists of a portion of the skeleton of another reptile discovered by Dr. Newberry, closely allied to the preceding but much larger, and with vertebræ presenting the same Batrachian features in the ridge-like spinous processes and the broad lobes of the articulating processes, but having also com-

bined with them largely and similarly developed ribs. In this case, the transverse processes if any existed, are not visible, as the vertebral column is turned a little to one side, and thereby one half of them is concealed in the matrix, while, on the other side, the parts are so much broken or covered up by the loose ribs as to prevent examination.

I have given no names to these last two reptiles, notwithstanding their great interest, as their remains were not sufficiently complete to enable me to determine with anything like accuracy their specific or generic characters. To add names to parts of animals, unless the remains are very characteristic, can only serve, as the history of science shows, to impede its progress and encumber it with useless synonyms.

ART. XVI.—*Fichtelite, a fossil carbo-hydrogen found in the "Fichtelgebirge" of North Bavaria;* by T. EDWARDS CLARK, Ph.D.*

THE rare fossil resin, which is the occasion of this paper and which I obtained for analysis through the kindness of Professor Liebig, was collected by Mr. Schmidt, apothecary in Wunsiedel. Near the neighboring town of Redwitz are beds of turf several feet in thickness, which contain large quantities of wood—stems and branches—in various stages of preservation.

The greater portion of this is pine wood, which is so little changed after lying in these turf beds for certainly hundreds of years, that, to all appearance, except that it has become quite dark in color, it does not differ from well dried wood of the same species which is still growing in the vicinity. It cuts and splits the same, burns about as well, and is little inferior in toughness.

Professor Unger,† who has made a microscopic examination of this wood, says that it evidently belongs to the still living species *Pinus sylvestris;* that it is very well preserved, but that in certain parts of the larger vessels a peculiar change has taken place, which has caused the walls of these vessels to lose their coherence and texture.

The other woods found in these turf beds are in a much worse state of preservation. The remains of birches (Betula alba), alders (Alnus glutinosa), and hazlenut (Corylus avellana), are quite numerous. The same species exist at present in the neighborhood. It is in this pine wood, which is still growing so plentifully as to give a name to the mountains of North Bavaria (Fichtelgebirge), that this fossil resin is found. It occurs principally in the form of shining scales between the annual rings,

* A portion of this paper first appeared in the "Annalen der Chemie und Pharmacie" of August, 1857.

† Annalen d. Physik u. Chemie, vol. lix, p. 55.

which have separated from one another. The method of extracting it, and its crystalline form we will consider farther on.

In 1837, Trommsdorff* received from Mr. Fikentscher a fossil resin, which was found, under exactly the same circumstances, in the well preserved stems of buried pines. The analysis, which he caused to be made, shows, however, that it is the same substance which was found some years later in a brown coal bed near Utznach in Switzerland, and that it differs both in its composition and in its melting point, 107° C., from the resin which we have analyzed.

In 1841, Bromeis† examined a fossil resin, which was also received from Mr. Fikentscher, and which was found, like the previous, in the light brown colored pine stems, between the annual rings, often in the form of flat prismatic crystals, colorless and without taste or smell. It proved however to be quite distinct from that analyzed by Trommsdorff, both in its composition and in its melting point, 46° C. Bromeis proposed the name Fichtelite for this.

In 1843, Schrötter‡ became possessed of a fossil resin also from Redwitz. This was extracted from the wood by ether, and allowed to crystallize, when it was found to be composed of two substances, one of which could not be crystallized, but went down as an oil. This he considered to be identical in composition with Fichtelite; but erroneously, for he overlooked the fact that in the analysis by Bromeis the old atomic weight of carbon was used. The crystalline portion of the resin received by Schrötter contained oxygen as well as carbon and hydrogen.

From this we see that at least three or four different carbohydrogen fossil resins have been obtained from the turf beds of Redwitz; and all have been found in the well preserved stems of this one species of pine tree. But the same has been remarked in other places where similar fossil resins have been found.

In the neighborhood of Utznach in Switzerland is a bed of brown coal from two to three feet in thickness, which contains numerous remains of pines, firs, birches and other trees, in various stages of preservation. The pine stems are almost unchanged. This bed of coal has long been considered to belong to the Tertiary formation, and is so spoken of by those who have noticed the fossil resins found in it. The remarkable state of preservation of the pine wood, and the occurrence of fossil resins in it, identical with or very similar to those discovered in the pine stems of the turf beds of Redwitz, have led me to investigate more closely the age of this bed of brown coal.

I found that an examination of the plants contained in it has recently been made by Professor Heer,§ who has published a

* Annalen d. Phar., vol. xxi, p. 126. † Annalen d. Phar., vol. xxxvii, p. 304.
‡ Annalen d. Phys. u. Chem., vol. lix, p. 55.
§ Neues Jahrbuch für Mineral. u. Geol. v. Leonhard u. Bronn., 1846, p. 213.

fine work on the "Tertiary Flora of Switzerland." He remarks that "the pine which Göppert describes as *Pinites sylvestris*, is evidently the same which we have in our brown coal at Utznach, and which is in every respect not to be distinguished from our living pines. The same is true of the birches and firs. We have found very few animal remains, but these appear to belong to species which still exist with us." Thus showing, as I anticipated, that this brown coal is of the same age as the turf beds of Redwitz.

Stromeyer* was the first to call attention to the existence of a fossil resin found in the wood preserved in this coal bed. To this he gave the name Scheererite.

Later in 1828, Könlein,† who had charge of the working of this bed of coal, described a resin which he had discovered as early as 1822 in the stems of pines occurring in the brown coal. For this, not knowing that Stromeyer had already described a fossil resin from the same bed under the name of Scheererite, he proposed the name of "Naphtaline resineuse prismatique," from its resemblance to naphtaline. Neither Stromeyer nor Könlein gave an analysis of the resin which they described.

In 1829, Macaire Princep‡ analyzed a resin which he, like Stromeyer, had received from Colonel Scheerer, as coming from the brown coal bed of Utznach. Its melting point was found to be but 2 degrees lower than that of Fichtelite. Macaire Princep accepted the name scheererite which Stromeyer had proposed.

Further, in 1838, Krauss§ analyzed a substance which he had obtained from the same locality. This resin in appearance resembled scheererite, but the analysis showed it to be different in composition. In this as well as in the melting point, it does not differ materially from the substance analyzed by Trommsdorff, which was found in the turf beds of Redwitz. Schrötter, who considers the two identical, proposes the name Könlite for them. While scheererite distills undecomposed, könlite yields a substance which melts by the warmth of the hand, and has a composition perhaps identical with that of tekoretin, which we have yet to notice. Krauss proposed the name pyro-scheererite for this latter.

Later, Haidinger‖ in an article comparing the crystalline form of hartite with that of what he supposed to be scheererite, and which he had received from Utznach, remarks that the latter melts at 46° C.

Steenstrup,¶ who has written considerably on the marshes and coal beds of Denmark, discovered in the stems of the pine trees, which are found in these in an almost perfect state of pres-

* Kastner's Archiv., vol. ix, p. 113.
† Ann. d. Phys. u. Chem., vol xii, p. 336.
‡ Ann. d. Phys. u. Chem., xv, p. 294.
§ Ann. d. Phys. u. Chem., xliii, p. 141.
‖ Ann. d. Phys. u. Chem., vol. liv, p. 261.
¶ Videnskab. Selskabs naturvid. og Math. Afhandlinger. 9 Deel., 1842.

ervation in the neighborhood of Holtegard, a fossil resin which was supposed to be scheererite. The other woods occurring with this pine (P. sylvestris) are the same as those of Redwitz and Utznach. The resin found by Steenstrup was shown by the analysis of Forchhammer to be composed of two carbo-hydrogens, and both quite distinct from scheererite. They were separated by dissolving in boiling alcohol and allowing to crystallize. Tekoretin, being less soluble than phylloretin, crystallized first. The former melts at 45° C., the latter at 87° C.

From this cursory view of the different carbo-hydrogens discovered in the three localities which have been mentioned, we perceive, that in each place a fossil resin occurs which melts at 45° or 46° C.—viz., Fichtelite described by Bromeis from Redwitz, scheererite (?) by Haidinger from Utznach, and tekoretin by Forchhammer from Holtegard. The relation which they bear to one another, through their actual composition, is noticed beyond.

We have still another locality to mention where a fossil resin is found, from the fact that this fossil, which was analyzed by Schrötter,* was considered by him to be very similar to scheererite and to have the same composition as tekoretin.

In 1841, Haidinger† discovered a fossil resin resembling scheererite in the brown coal beds of Oberhart not far from Vienna. One part of these beds contains numerous stems of a sort of pine tree, which are preserved either as bituminous, or as petrified wood, i. e., quartz in the form of wood. In the different layers and cross breakings of these stems the resin which is called hartite is found. These coal beds have at present an inclination of 70°, and are considered to belong to the tertiary formation. The pine wood in which the resin occurs was examined by Unger‡ and pronounced to belong to the species *Peuce acerosa*, Ug., which is very common in the brown coal formation. Hartite, which was analyzed by Schrötter, melts at 74° C. This is the only carbo-hydrogen fossil found in the coal beds of Oberhart, while at Redwitz there are at least two; at Utznach three have been described, including one derived from the distillation of könlite; and from Holtegard two have been analyzed by Forchhammer.

We have thus briefly alluded to the various fossil resins found in the four different localities mentioned, because it will be necessary to speak of the relation which they bear to one another and to the substance which we have analyzed. As to the actual composition of several of these fossils much doubt exists, for most of the analyses were made at a time when the atomic

* Ann. d. Phys. u. Chem., vol. lix, p. 37.
† Ann. d. Phys. u. Chem., vol. liv, p. 261.
‡ Ann. d. Phys. u. Chem., vol. lix, p. 41.

weight of carbon was considered to be 6·125, and the method of analysis was much less perfect than at present.

We shall now proceed to notice more specially the substance which we have received for analysis. It is found principally between the annual rings of the wood, which have separated or are still loosely joined to one another. Here it forms layers, often one-tenth of an inch in thickness, of shining transparent scales, having more or less of a yellowish tinge, and lapping one over the other. In some parts of the wood are what appear to be minute granules of this resin mixed with woody matter, but when examined under the microscope they prove to be small crystals, with their faces obliquely inclined to one another. I did not succeed in finding any that were large and regular enough for determining the crystalline form.

But this substance is not confined to the annual layers; for if the wood is split in any direction whatever, numerous shining points appear, showing that it is completely saturated with it. In order to obtain this from the wood, the latter is finely cut up with a turning lathe, or by any other convenient means, and then boiled in ether for several hours. The extract is then poured off, fresh ether is added, and again submitted to two or three hours boiling. The two extracts are now poured together and considerably concentrated by distilling off a part of the ether. Strong alcohol is added to this till all remains dissolved.

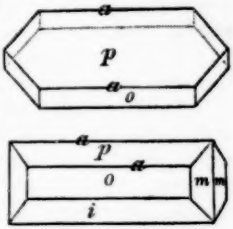
From this it was found impossible to obtain crystals, although exposed to a temperature below 0° C.; a reddish oil went down instead. So in order to separate the resin from other organic bodies, which were presumed to be present, and which were supposed to prevent the forming of crystals, the acetate of lead was added. The large and heavy precipitate, which went down, was thrown on a filter, and the filtrate, after being freed from the excess of acetate of lead by sulphuretted hydrogen, and boiled with the precipitate for a time to decolorize it, was exposed to a cold of a few degrees below 0° C., when long prism-shaped crystals were formed.

Any foreign substance, or a crystal of this resin thrown into the alcoholic solution, assists the first forming of crystals very materially.

Before cutting up the wood, it is best to scrape off as much resin as possible, for this portion, dissolved in alcohol and ether, crystallizes quite easily.

The precipitate occasioned by the acetate of lead, which is not soluble in ether, was mixed with alcohol and decomposed by a current of sulphuretted hydrogen. In the filtrate of this new precipitate, crystals were formed when exposed to a temperature below 0° C. These we have not yet examined.

The crystals of this resin thus artificially formed are oblique rhombic prisms with orthodiagonal faces. Sometimes an oblique end face is present behind. In the prevailing form the angles of the side faces $m:m=97°$ and 83°: the end face p to the orthodiagonal face $o=127°$: the second oblique end face behind $i:o=128°$; and $p:i=105°$. The orthodiagonal face cuts off the acute side angle of the prism m. The crystals are lengthened in the direction of the orthodiagonal: m in most very short. If the face p is adjusted in the stauroscope with the sides $a\,a$, the cross stands normal; a proof that the crystallization is not triclinic. The measurements could be made only by the reflection of candle light with the use of the lens.



The melting point is 46° C.; but the temperature at which this substance solidifies again is much lower, viz. 36° C., making a difference of ten degrees between the melting and freezing points. These observations were carefully made by experimenting on several different portions of the resin. This somewhat strange behavior has already been observed in other bodies, e. g. oleic acid when melted does not solidify till cooled to 4° C.; its melting point is 14° C.: dœglinic acid, which melts at 16° C., congeals a few degrees above 0° C.

To determine the boiling point of this substance, about five grams were put into a small retort holding a thermometer running up to 320° C. The latter was lowered almost to the surface of the melted resin, and the heat gradually increased till the mercury reached 310°, when the thermometer was taken out, and the retort more strongly heated. Soon, oil drops began to collect in the neck of the latter, which on cooling assumed more or less of a crystalline structure. The distilled portion when dissolved in alcohol and ether crystallized like the original substance, and possessed the same melting and freezing points; showing that it suffered no change by distillation. We may safely say that the boiling point is above 320° C., for the thermometer was rapidly rising when it was taken out. A peculiar but agreeable odor was given out during the distillation, and a small part of the resin was decomposed, accompanied by the separation of coal.

Anhydrous sulphuric acid produces a total decomposition of the substance. A small portion was put into a test tube, and to this the sulphuric acid was added, when, although cold, a violent reaction took place, fumes of sulphurous acid were given out, and the whole tube was blackened with coal.

To another portion Nordhausen acid was added, and then heated in the water-bath. Sulphurous acid was slowly given out, and the solution became deep red. In order to see if any combination with sulphuric acid had taken place, water was added and the whole heated with carbonate of baryta. The precipitate was separated, but the filtrate, which was greatly concentrated by evaporation, yielded no crystals of any soluble salt of baryta.

This experiment was often made in different ways, but without obtaining any combination with sulphuric acid.

To another portion of this resin fuming nitric acid was added, and heated carefully in the water-bath. Soon a violent reaction took place, red fumes of nitrous acid were given out in large quantity. After the action of the nitric acid was finished, the whole was evaporated to one-third its volume, and water added, causing a white precipitate. This was thrown on a filter, washed out, and dissolved in alcohol and ether. The reddish solution was boiled with animal carbon to decolorize it, and then exposed to a temperature several degrees below 0° C. But instead of crystals being formed, an oily substance, which probably holds nitrous acid, was sent down as the ether evaporated. The filtrate of the precipitate caused by the action of water on the nitric acid solution, was evaporated to dryness over the water-bath; the residue was found to contain oxalic acid.

If this resin is thrown into cold fuming nitric acid and allowed to stand for two or three days, it dissolves entirely; but when precipitated from this solution by water, and dissolved in alcohol and ether, it behaves like the last, going down as a reddish oil. A mixture of fuming nitric and sulphuric acids seems to act like nitric acid alone.

Although we have not succeeded in obtaining combinations with nitrous acid, which we know to be such, yet we do not doubt but that they are formed, from the fact that they have been obtained from other substances which are very similar to this.

Chlorine gas in contact with this resin in a melted state combines with it. The experiment is best made by putting a few grams in a small Liebig's drying apparatus, the lower part of which runs horizontally. This is placed in a water-bath, the temperature of which must be kept above 46° C. With this bent tube a retort, in which chlorine gas is generated, is connected. A higher or lower compound of chlorine is formed, in accordance with the length of time that the gas is passed over the melted substance; or two or three compounds may be formed at the same time. Fumes of hydrochloric acid appear at the open end of the tube.

The action of bromine is of course similar to that of chlorine. Hydrobromic acid is given out, and higher or lower compounds are formed, as the quantity of bromine used is greater or less. The substance should be melted in a flask and the bromine added from time to time.

This resin was obtained pure for analysis by several re crystallizations from its solution in alcohol and ether. The combustions were made with chromate of lead, and with rolls of fine oxydized copper wire in the front part of the tube. Three out of several analyses are here given.

I. 0·3324 grm. of substance gave
1·0591 " carbonic acid and
0·3819 " water.

II. 0·4314 " of substance gave
1·3761 " carbonic acid and
0·4980 " water.

III. 0·4008 " of substance gave
1·2859 " carbonic acid and
0·4689 " water.

These give the following percentages:

	I.	II.	III.
Carbon,	86·89	87·00	87·50
Hydrogen,	12·86	12·83	12·99

The average of the three and the corresponding formula are as follows,

	Average.	Calculated.
Carbon,	87·13	C_8 87·27
Hydrogen,	12·86	H_7 12·73

This gives as the empirical formula for this resin C_8H_7. The other analyses confirm this result.

We will now proceed to compare this formula with those obtained by others for several of the fossil resins already mentioned, viz., with Fichtelite analyzed by Bromeis, with hartite analyzed by Schrötter, and with tekoretin and phylloretin analyzed by Forchhammer. But first, we must allude to a matter which has given us no little trouble.

All the above mentioned resins, with the exception of hartite, were analyzed when the atomic weight of carbon was held to be 6·125, hence too much carbon was almost always obtained in an analysis. Now in books on organic chemistry, and in chemical journals when these fossils are alluded to, this fact seems generally to have been overlooked. We will give two or three instances out of the very many which we have noticed.

Schrötter,* who analyzed hartite, compares his results with those obtained by Forchhammer for tekoretin, and remarks that the two substances are very probably identical in composition, and only differ in their melting points. We give the results as obtained by each:

* Ann. d. Phys u. Chem., vol. lix, p. 44.

	Hartite.	Tekoretin.
Carbon,	87·47	87·19
Hydrogen,	12·04	12·81

Now if we overlook the fact that in the analysis of hartite the atomic weight of carbon was taken as 6, but in the analysis of tekoretin as 6·125, then Schrötter's remark seems to be correct. The actual difference in composition will be seen if we in both cases take the atomic weight of carbon as 6.

Hartite.	Tekoretin.
87·47	85·89
12·04	12·81

Again Gerhardt* commits the same error, but in a different way. On noticing scheererite (könlite) he gives the composition in one hundred parts as obtained by Krauss, who took the atomic weight of carbon as 6·125, but affixes to this a formula in which it is taken as 6: e. g.

		nX^2	H
Carbon,	92·45	92·	8
Hydrogen,	7·42	7·	7

Tekoretin, phylloretin, and other resins are noticed in the same way by Gerhardt. Löwig in his "Organic Chemistry" has many similar errors. The same oversight is also common in works on mineralogy.

Let us now compare the result which we have obtained with the composition of several similar fossil resins. Those analyses which were made when the atomic weight of carbon was held to be 6·125 we have recalculated. The four substances which bear perhaps the nearest relation to that which we have analyzed, are Fichtelite, hartite, tekoretin, and phylloretin. Their composition in one hundred parts is

	Fichtelite.	Hartite.	Tekoretin.	Phylloretin.
C	87·95	87·47	85·89	88·88
H	10·70	12·04	12·81	9·22

They require probably the following formulas: Fichtelite C_5H_4, hartite C_6H_5, tekoretin CH, phylloretin C_3H_2. Though the numbers obtained from the analysis of Fichtelite by Bromeis indicate a different formula, yet we are disposed to consider it identical with the substance which we have analyzed; for they both occur under the same circumstances and in the same peat beds; and moreover they have a common melting point. Fichtelite also distills without being decomposed, and behaves toward alcohol and ether as does this resin.

The difference in composition, indicated by the analyses, may perhaps be accounted for by the fact that Bromeis analyzed Fichtelite just as it was obtained from the wood, without re-

* Traité de Chemie Organique, Tome quatrième, p. 398.

crystallizing it, and hence it was necessarily impure. Rather than increase the confusion already existing in the nomenclature of these and allied substances, we shall adopt the name given by Bromeis.

We should not forget to notice that Trommsdorff has also analyzed a fossil resin coming from Redwitz, and found under the same circumstances, in the stems of *Pinus sylvestris*, and having the same outward appearance as Fichtelite; but in its melting point, 107° C., and in its composition, it differs greatly: viz.

	Könlite (?)
Carbon,	91·05
Hydrogen,	7·57

The formula obtained for hartite stands nearer that of the fossil resin which we have analyzed; its crystals are also monoclinic; towards alcohol, ether, and sulphuric acid it behaves the same; and during distillation but a small portion is decomposed; but its melting point is much higher, 74° C., besides it occurs in another fossil pine, *Peuce acerosa*, Ug., and in another geological formation, being as to its origin much older.

Tekoretin resembles this resin in every particular except in composition. Its melting point is 45° C.; it distills at nearly 336°; possesses the same solubility in alcohol and ether; the effect of nitric acid and chlorine gas is the same, forming two compounds with the latter, which Forchhammer did not succeed in separating; and it is also found in the buried stems of *P. sylvestris;* but the formula required by its analysis obliges us for the present to consider it as another resin.

Phylloretin, which like the latter is found in the pine stems in the marshes of Holtegard, though distilling at a high temperature and forming compounds with chlorine, differs not only in composition, but in its melting point, 87° C., from the fossil resin which we have described.

We have still another carbo-hydrogen resin to notice, which was the first described of all these in 1827. This was called scheererite. It melts at 44° C. and distills, without being decomposed, at 90° C.

Some confusion exists with regard to this fossil, from the fact that Krauss* has given the analysis of a substance under the name of scheererite, which had, it is true, been obtained from the coal beds of Utznach, like that described by Stromeyer and Macaire Princep, but which melts at 107° C.; is decomposed by distillation, and has a composition quite different from scheererite as given by Macaire Princep:

	Scheererite.
Carbon.	71 91
Hydrogen,	24·00

* Ann. d. Phys. u. Chem., vol. xliii, p. 141.

The inexactness of the analysis leaves much doubt as to its true composition. The substance was very volatile, and only one analysis was made. Macaire Princep himself was not satisfied with the result. Since he made the analysis, no substance has been found in the coal beds of Utznach which melts at 44° C. and distills at 90° C.

We give here a table of those fossil resins to which we have referred, together with their melting and boiling points, and also the effect of chlorine, nitric and sulphuric acids on them. We have thought the percentage of carbon and hydrogen found would give a better idea of the relation of these fossils to one another, than their formula, for many of the latter, deduced from the amount of carbon and hydrogen obtained, are doubtful.

	Carbon.	Hydrogen.	Melt'g point.	Boiling point.	Effect of Chlorine.	Of Nitric Acid.	Of sulphuric acid.
Fichtelite by Bromeis,	87·95	10 70	46° C.	Unknown, not decomposed.	unknown	Unknown.	unknown.
Fichtelite by Clark,	87·13	12·86	46° C.	Above 320° C.	combines	Oxalic acid, and NO_4 combination (?)	blacken'd.
Tekoretin,	85·89	12 81	45° C.	Of quicksilver.	do.	do	unknown.
Scheererite by Haidinger,	unknown	unknown	46° C.	Unknown.	unknown	Unknown.	do.
Scheererite by Princep,	71·91	24·00	44° C.	90° C.	do.	do.	blacken'd.
Hartite,	87·47	12·04	74° C.	Very high.	do.	do.	do.
Phylloretin,	88·88	9 22	87° C.	Of quicksilver.	combines	Oxalic acid, and NO_4 combination (?)	unknown
Könlite (?) by Trommsdorff,	91·05	7·57	107° C.	Unkn'n, not decomposed	unknown	No effect.	blacken'd.
Könlite by Krauss,	91·12	7·421	114° C.	At 200° C., decomposed.	do.	Dissolves it.	do.

The rational formula for any one of the fossils which we have mentioned has not yet been determined. We only know the empirical formula. None of the products resulting from their combination with chlorine, bromine, sulphuric or nitric acids have been analyzed. For this purpose we have formed and analyzed several chlorine and bromine combinations of Fichtelite. Chlorine gas was passed over a few grains of it as already described, for the space of one-half hour. It was then dissolved in alcohol and ether, and stood in the cold to crystallize. After standing several days, all the undecomposed resin crystallized out.

From the mother liquor two combinations with chlorine were obtained, neither of which could be crystallized, though exposed to a cold several degrees below 0° C. The first of these combinations is a clear colorless transparent oil; the other, which is of a yellowish color, we did not obtain in sufficient quanty for analysis.

Over another portion of Fichtelite a stream of chlorine gas was passed for two hours. This was then dissolved in alcohol and ether as the last. Two oils were obtained, neither of which could be crystallized. The one which was first precipitated was

of a deep yellow color and perfectly clear; the other was of a dark red color. There was too little of the latter for analysis.

For determining the amount of chlorine and bromine contained in the oils obtained, the combustions were made with caustic lime. For determining the amount of carbon and hydrogen simply chromate of lead was used, having the combustion tube longer than usual.

Before giving the results obtained, I must remark that it is greatly to be regretted that I did not succeed in obtaining these combinations in a crystalline form; for then there could be no doubt as to their purity. As it is, a small portion of Fichtelite may have been held in solution by the oils, and so of course have affected the results obtained. I therefore present the following analyses with the hope that some one may hereafter be more fortunate than I have been in forming crystalline combinations of this resin with chlorine and bromine.

First chlorine combination.

I. 0·4192 grm. of substance gave
1·1868 " carbonic acid and
0·4216 " water.

II. 0·6903 " of substance gave
0·3156 " chlorid of silver.

Hence

	Calculated.	Found.
C_{30} =	77·555	77·213
H_{38} =	10·987	11·173
Cl_2 =	11·458	11·304

Second chlorine combination.

I. 0·3933 grm. of substance gave
1·0013 " carbonic acid and
0·3443 " water.

II. 0·5411 " of substance gave
0·4432 " chlorid of silver.

Hence

	Calculated.	Found.
C_{30} =	69·783	69·433
H_{37} =	9·595	9·726
Cl_3 =	20·621	20·250

In order to obtain bromine combinations, the resin was acted upon by bromine as previously described, and dissolved in alcohol and ether. After standing several days in the cold most of the time below 0° C. the undecomposed substance had entirely crystallized out. By treating the mother liquor as in the case of the chlorine compounds, two oils were obtained: one of a light red color and perfectly clear, the other dark red and much more consistent.

First bromine combination.

I. 0·4169 grm. of substance gave
1·1646 " carbonic acid and
0·4151 " water.

II. 0·3909 " of substance gave
1·0886 " carbonic acid and
0·3867 " water.

Hence

	Calculated.	Found. I.	Found. II.
C_{20} =	76·315	76·186	75·95
H_9 =	10·970	11·063	10·99
Br =	12·715	12·751	13·05

Second bromine combination.

0·4823 grm. of substance gave
0·257 " bromid of silver.

Hence

	Calculated.	Found.
C_{80} =	67·801	
H_{63} =	9·605	
Br_2 =	22·592	22·673

We have thus obtained the four following formulas for the chlorine and bromine compounds:

$C_{80}H_{69}Br_1$, $C_{80}H_{68}Br_2$, $C_{80}H_{68}Cl_2$, $C_{80}H_{66}Cl_4$.

Hence the rational formula for Fichtelite would seem to be

	Calculated.	Found.
C_{30} =	87·273	87·13
H_{70} =	12·727	12·86

This is of course quite an unexpected result, although the rational formula for none of these fossil resins has previously been determined. Other carbo-hydrogen substances have however been described with very high formulas, e. g., *Melene* and *Cerene*. The formula for the former is $C_{60}H_{60}$, and for the latter $C_{54}H_{54}$. Moreover both of the substances, like that which we have analyzed, have many of the properties of paraffine, and form compounds with chlorine.

There are two objections to reducing this formula to $C_{46}H_{38}$. The first is that it gives an uneven number of hydrogen atoms, and secondly that in the first bromine compound it requires one-half an atom ($Br_{\frac{1}{2}}$) of bromine. Laurent and others have however expressed half atoms in various formulas.

ART. XVII.—*On the Characters, Principles of Division, and Primary Groups of the Class Mammalia;* by Professor OWEN, F.R.S., F.L.S., Superintendent of the Natural History Departments in the British Museum.*

(Concluded from page 18.)

Primary Divisions of the Mammalia.—The question or problem of the truly natural and equivalent primary groups of the class *Mammalia* has occupied much of my consideration, and has ever been present to my mind when gathering any new facts in the anatomy of the Mammalia, during dissections of the rarer forms which have died at the Zoological Gardens, or on other opportunities.

The peculiar value of the leading modifications of the mammalian brain, in regard to their association with concurrent modifications in other important systems of organs, was illustrated in detail in the Hunterian course of lectures on the Comparative Anatomy of the Nervous System, delivered by me at the Royal College of Surgeons in 1842. The ideas which were broached or suggested during the delivery of that course, I have tested by every subsequent acquisition of anatomical knowledge, and now feel myself justified in submitting to the judgment of the Linnean Society, with a view to publication, the following fourfold primary division of the mammalian class, based upon the four leading modifications of cerebral structure in that class.

The brain is that part of the organization which, by its superior development, distinguishes the Mammalia from all the inferior classes of VERTEBRATA; and it is that organ which I now propose to show to be the one that by its modifications marks the best and most natural primary divisions of the class.

In some mammals the cerebral hemispheres are but feebly and partially connected together by the 'fornix' and 'anterior commissure:' in the rest of the class a part called 'corpus callosum' is added, which completes the connecting or 'commissural' apparatus.

With the absence of this great superadded commissure† is associated a remarkable modification of the mode of development of the offspring, which involves many other modifications; amongst which are the presence of the bones called 'marsupial,' and the non-development of the deciduous body concerned in the nourishment of the progeny before birth, called 'placenta;'

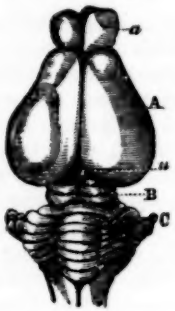
* This paper is cited from the Journal of the Proceedings of the Linnean Society of London. Read February 17th and April 21st, 1857.

† "On the Structure of the Brain in Marsupial Animals," Philos. Trans., 1837, p. 87.

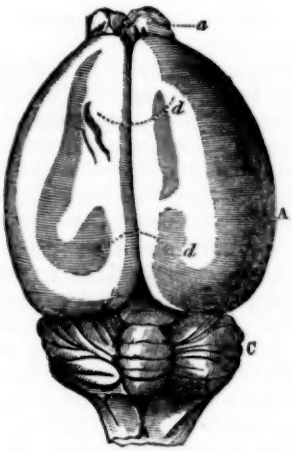
the young in all this 'implacental' division being brought forth prematurely, as compared with the rest of the class.

This first and lowest primary group, or subclass, of Mammalia may be termed, from its cerebral character, *LYENCEPHALA*,*—signifying the comparatively loose or disconnected state of the cerebral hemispheres. The size of these hemispheres (fig. 1, A) is such that they leave exposed the olfactory ganglions (*a*), the cerebellum (C), and more or less of the optic lobes (B); their surface is generally smooth; anfractuosities, when present, are few and simple.

1.—Brain of Opossum.



2.—Brain of Beaver.



The next well-marked stage in the development of the brain is where the corpus callosum (indicated in fig. 2 by the dotted lines *d*, *d*) is present, but connects cerebral hemispheres as little advanced in bulk or outward character as in the preceding subclass; the cerebrum (A) leaving both the olfactory lobes (*a*) and cerebellum (C) exposed, and being commonly smooth, or with few and simple convolutions in a very small proportion, composed of the largest members of the group. The mammals so characterized constitute the subclass *LISSENCEPHALA*† (fig. 2).

In this subclass the testes are either permanently or temporarily concealed in the abdomen: there is a common external genito-urinary aperture in most; two precaval veins ('superior' or 'anterior venæ cavæ') terminate in the right auricle. The squamosal in most, and the tympanic in many, retain their primitive

* λίω, to loose, and ἐγκέφαλος, brain.

† λισσὸς, smooth, and ἐγκέφαλος, brain.

separation as distinct bones. The orbits have not an entire rim of bone. Besides these more general characters by which the Lissencephala, in common with the Lyencephala, resemble Birds and Reptiles, there are many other remarkable indications of their affinity to the Oviparous Vertebrata in particular orders or genera of the subclass. Such, *e. g.*, are the cloaca, convoluted trachea, supernumerary cervical vertebræ and their floating ribs, in the three-toed Sloth; the irritability of the muscular fibre, and persistence of contractile power in the Sloths and some other Bruta; the long, slender, beak-like edentulous jaws and gizzard of the Anteaters; the imbricated scales of the equally edentulous Pangolins, which have both gizzard and gastric glands like the proventricular ones in birds; the dermal bony armor of the Armadillos like that of loricated Saurians; the quills of the Porcupine and Hedgehog; the proventriculus of the Dormouse and Beaver; the prevalence of disproportionate development of the hind-limbs in the *Rodentia;* coupled, in the Jerboa, with confluence of the three chief metatarsals into one bone, as in birds; the keeled sternum and wings of the Bats; the aptitude of the *Cheiroptera*, *Insectivora*, and certain *Rodentia* to fall, like Reptiles, into a state of true torpidity, associated with a corresponding faculty of the heart to circulate carbonized or black blood:—these, and the like indications of co-affinity with the *Lyencephala* to the oviparous air-breathing Vertebrata, have mainly prevailed with me against an acquiescence in the elevation of different groups of the Lissencephala to a higher place in the Mammalian series, and in their respective association, through some single character, with better-brained orders, according to mammalogical systems which, at different times, have been proposed by zoologists of deserved reputation. Such, *e. g.*, as the association of the long-clawed *Bruta* with the *Ungulata*,* and of the shorter-clawed Shrews, Moles and Hedgehogs, as well as the Bats, with the *Carnivora*,† of the Sloths with the *Quadrumana*,‡ of the Bats of the same high order;§ and of the *Insectivora* and *Rodentia* in immediate sequence after the Linnean 'Primates,' as in the latest published 'System of Mammalogy,' from a distinguished French author.‖

* Macleay, Linn. Trans., vol. xvi (1833); Gray, Dr. J. E., Mammalia in the British Museum, 12mo, 1843, p. xii.

† Cuvier, Règne Animal, 1829, p. 110.

‡ De Blainville, Ostéographie, 4to, fasc. 1, p. 47 (1839).

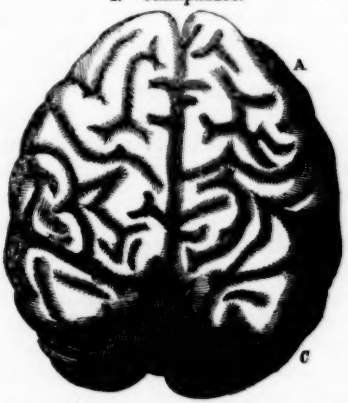
§ Linnæus, Systema Naturæ.

‖ Prof. Gervais, Zoologie et Paléontologie Française, 4to, 1852, p. 194. This scheme is avowedly an adoption of that proposed by Professor Milne-Edwards, in the first volume of the 3rd series of the 'Annales des Sciences Naturelles,' 1844, in a paper entitled 'Considérations sur quelques Principes relatifs à la Classification Naturelle des Animaux,' &c.; in referring to which, M. Gervais states his conviction that Milne-Edwards, "a mis hors de doute les rapports des Rongeurs avec les premiers Mammifères."—Annales des Sciences Naturelles, ser. iii, vol. i, p. 251. The

The third leading modification of the Mammalian cerebrum is such an increase in its relative size, that it extends over more or less of the cerebellum; and generally more or less over the olfactory lobes. Save in very few exceptional cases of the smaller and inferior forms of *Quadrumana* (fig. 3), the superficies is folded into more or less numerous gyri or convolutions,—whence the name *GYRENCEPHALA*,* which I propose for the third subclass of Mammalia (fig. 4).

3.

4.—Chimpanzee.



In this subclass we shall look in vain for those marks of affinity to the *Ovipara*, which have been instanced in the preceding subclasses. The testes are, indeed, concealed, and through an

high and justly-earned reputation of both these naturalists renders it incumbent on me to state the doubts with respect to the actual affinity of the Rodentia to the Quadrumana which remained on my mind after an attentive perusal of the arguments urged by Milne-Edwards. The first of these arguments is based upon an alleged resemblance of placental structure, expressed by the term "a placenta discoide," applied as a character to the Bimana, Quadrumana, Cheiroptera, Insectivora and Rodentia, collectively.

The degree of resemblance in outward form, between the placenta of the Rat or Hare, on the one hand, and the *Mycetes* and *Macacus* on the other, seems to me to be more than counterbalanced by the difference of structure. The pedunculate and cotyloid placenta of the Rat consists of fœtal parts exclusively; the maternal areolar portion is as distinct from it as it is in the cotyledon of the Ruminant, and is a persistent structure of the uterus. The discoid placenta of the Monkey includes a large proportion of maternal cellular structure, which comes away with the fœtal portion. The difference in the organic interblending of the circulatory organs of mother and offspring, between the *Rodentia* and *Quadrumana*, is of much more real importance than the degree of superficial similarity. Still more significant, in regard to genetic grounds of affinity, is the great difference in the development and function of the vitellicle or umbilical sac in the fœtal membranes of the two orders. But, as regards outward form, the cotyloid placenta of the *Muridæ* differs more from the thin, expanded and subdivided placenta of the Hare, than it does from that of the Marmoset Monkey: then, it signifies something in the argument drawn

* γυρόω, to bend or wind, and ἐγκέφαλος, brain.

obvious adaptive principle, in the Cetacea; but in the rest of the subclass, with the exception of the Elephants, they pass out of the abdomen, and the Gyrencephalous quadrupeds, as a general rule, have a scrotum. The vulva is externally distinct from the anus. With the exception, again, of the Elephants, the blood from the head and anterior limbs is returned to the right auricle by a single precaval trunk. The mammalian modification of the Vertebrate type attains its highest physical perfections in the *Gyrencephala*, as manifested by the bulk of some, by the destructive mastery of others, by the address and agility of a third order. And, through the superior psychological faculties—an

from similarity of form, that there are two distinct discoid placenta in *Callithrix* as in *Cercopithecus*, *Macacus* and *Semnopithecus*; whilst in *Mycetes*, as in *Troglodytes*, there is but one such placenta.

The structure of the discoid placenta in the *Pteropus*, like that of the Rat, more resembles that of the fœtal portion of the cotyledon in the Cow than that of the cellulo-vascular spongy placenta of the *Quadrumana*; and this difference, with the more important one of the larger umbilical sac, appears to me to greatly outweigh the degree of resemblance in mere outward form of the placenta. Any argument in favor of the affinity of the *Cheiroptera* to the *Quadrumana*, based on that degree of resemblance, must be affected by the prevalence of the double discoid placenta in the *Quadrumana*. Since Hunter first made known that modification* in a species of *Macacus*, which, from a comparison of the fœtus now preserved in the Museum of the Royal College of Surgeons, I believe to be the 'Wrinkled Baboon' of Shaw (*Macacus rhesus*, Desm.), Professor Breschet has described and figured the two separate discoid placentæ in the small South American Squirrel-monkey (*Callithrix sciureus*, Kuhl), in the Green Monkey (*Cercopithecus sabæus*, Desm.), and in the Long-nosed Monkey (*Semnopithecus nasicus*). Yet this well-marked modification of the cellulo-vascular placenta is not constant in the *Quadrumana*, or even in the primary groups of the order. In the Platyrhines, *e. g*, the Howler (*Mycetes seniculus*, Kuhl) has a single placenta; and amongst the Catarhines, I have ascertained that, in the Chimpanzee (*Troglodytes niger*) the placenta is single, as in the Human subject.

The five flat placental lobes, virtually as distinct as if they were separate placentæ, in the Hare, resemble more the subdivided placentæ of the Sloth than the single hemispheroid pedunculate placenta of the Rat, or the flattened circular placenta of the Howler Monkey. In short, the observed differences of form in the placentæ of the *Rodentia*, *Insectivora*, *Cheiroptera* and *Quadrumana* by no means justify the use of one general term as applicable to the whole.†

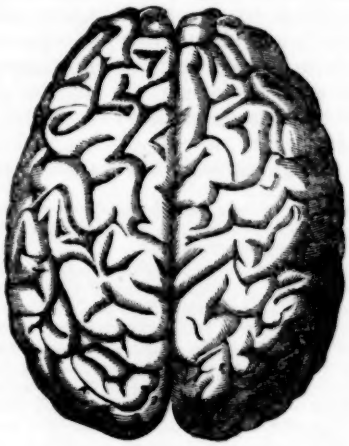
The second argument for the association of the *Insectivora*, *Cheiroptera* and *Rodentia* with the *Quadrumana* is taken from alleged conformity of cerebral structure.

"Le cerveau d'un Rongeur diffère à peine de celui d'un Insectivore; il existe aussi une resemblance extrême entre l'encephale d'un Insectivore et celui de certains Quadrumanes;" whence it is meant to be inferred, that there is the same extreme resemblance between the brain in *Rodentia* and certain *Quadrumana*. In my paper on the 'Brains of the Marsupialia,' (Phil. Trans., 1837,) I have described and figured (pl. v, p. 93) the brain of a Beaver (see fig. 2, p. 178) and that of a small Monkey (*Midas rufimanus*, fig. 3, p. 180), showing the absence of cerebral convolutions in both. As the cerebral hemispheres have since been shown to be equally smooth in other *Hapalidæ* of Isodore Geoffroy, in the Potto Lemur‡ (*Perodicticus*, Bennett), in *Microcebus*§, and with few and feeble traces of convolutions in *Stenops tardigradus* (Vrolik, d'Anatomie comparée sur le genre *Stenops*, in N. Verhand. der 1ste Klasse Koninkl. Nederl. Inst. Amsterdam, Oct. 1843), there is, to that extent, in the Quadrumanous order, a superficial resemblance to the non-convoluted brains of the *Rodentia* and *Insectivora*; but it is attended by that more important difference

* Animal Economy, 4to, 1780. † Anna'es des Sciences Nat., tom. cit., p. 96.
‡ Bijdrage tot de Kennis van den Potto van Bosman, 4to, 1851, V. der Hoeven.
§ Comptes Rendus de l'Acad. des Sciences, Janiver 19, 1852.

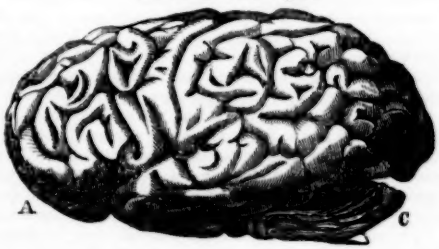
adaptive intelligence predominating over blind instinct—which are associated with the higher development of the brain, the *Gyrencephala* afford those species which have ever formed the most cherished companions and servitors, and the most valuable sources of wealth and power, to mankind.

5.—Negro.



In Man the brain presents an ascensive step in development, higher and more strongly marked than that by which the preceding subclass was distinguished from the one below it. Not only do the cerebral hemispheres (figs. 5 and 6, A) overlap the olfactory lobes and cerebellum, but they extend in advance of the one, and farther back than the other (fig. 6, C). Their posterior development is so marked, that anatomists have assigned to that part the character of a third lobe; it is peculiar to the genus *Homo*, and equally peculiar is the 'posterior horn of the lateral ventricle,' and the 'hippocampus minor,' which charac-

6.—Side view, Negro.



in the form and proportions of the cerebral hemispheres, of which I express my estimate by the system of Classification proposed in the present paper.

The smooth hemispheres of the brain of the *Midas* (fig. 3, A) "extend, as in most of the *Quadrumana*, over the greater part of the cerebellum (C)," (Phil. Trans., 1837, p. 93); it resembles, in short, the brain of the Human embryo before the cerebral surface begins to be folded; whereas in the *Insectivora*, in the Beaver, and even in the Capybara, in which there are a few shallow anfractuosities, the cerebral hemispheres leave the cerebellum quite exposed.

With regard to the alleged contrast between the brains of the *Rodentia* and *Carnivora*, in the breadth of the anterior and middle part of the cerebral hemispheres, a comparison of the brains of the Beaver and Coatimondi, and of the Porcupine and the Civet Cat, leaves me entirely unable to appreciate the force of the remark.

The third argument for the high position of the *Rodentia*, *Cheiroptera* and *Insectivora* in the Mammalian scale, is deduced from some particulars of their osteology,

terize the hind lobe of each hemisphere. The superficial grey matter of the cerebrum, through the number and depth of the convolutions, attains its maximum of extent in Man.

Peculiar mental powers are associated with this highest form of brain, and their consequences wonderfully illustrate the value of the cerebral character; according to my estimate of which, I am led to regard the genus *Homo*, as not merely a representative of a distinct order, but of a distinct subclass of the Mammalia,* for which I propose the name of '*ARCHENCEPHALA*'† (fig. 6).

With this preliminary definition of the organic characters, which appear to guide to a conception of the most natural primary groups of the class *Mammalia*, I next proceed to define the groups of secondary importance, or the subdivisions of the foregoing subclasses.

In the Lyencephalous Mammalia some have the 'optic lobes' simple, others partly subdivided, or complicated by accessory ganglions, whence they are called 'bigeminal bodies.' The Lyencephala with simple optic lobes are 'edentulous' or without calcified teeth, are devoid of external ears, scrotum, nipples, and marsupial pouch: they are the true 'testiconda;' they have a coracoid bone extending from the scapula to the sternum, and also an epicoracoid and episternum, as in Lizards; they are unguiculate and pentadactyle, with a supplementary tarsal bone supporting a perforated spur in the male. The order so charac-

and principally from the common presence of the clavicle in them, as contrasted with its constant absence in the *Carnivora* and *Ungulata*. The clavicle is present in all *Quadrumana*, but it is not a peculiar characteristic of the higher forms of the Mammalian class. It is much more constant in the class of Birds and Reptiles: it is present in the *Monotremes*, in *Marsupials*, and in most *Bruta*. An affinity of the *Insectivora* and of the claviculate *Rodentia* with a lower vertebrate type, might therefore be inferred from the clavicle, at least with as much reason, as with Apes and Man. As to the shape of the articular cavity for the mandible, the *Rodentia* differ more from the *Quadrumana* in this particular than the *Carnivora* do; whilst, in respect of the size, form, and persistent individuality of the tympanic bone, the *Rodentia* plainly show their more essential relations to the oviparous type; the *Carnivora* resembling the *Quadrumana* in the early coalescence of the petro-tympanic with the squamosal elements of the temporal bone.

Such are some of the considerations which have induced me to set a different value than M. Gervais does, on the arguments adduced by Prof. Milne-Edwards in favor of the association of the *Rodentia* with the *Quadrumana*, in a highly placed primary group of the Mammalian class.

* Not being able to appreciate, or conceive of the distinction between the psychical phenomena of a Chimpanzee and of a Boschisman, or of an Aztec with arrested brain-growth, as being of a nature so essential as to preclude a comparison between them, or as being other than a difference of degree, I cannot shut my eyes to the significance of that all-pervading similitude of structure—every tooth, every bone, strictly homologous,—which makes the determination of the difference between *Homo* and *Pithecus* the anatomist's difficulty. And, therefore, with every respect for the author of the "Records of Creation," (8vo, 1816, pp. 18–21,) I follow Linnæus and Cuvier in regarding man as a legitimate subject of zoological comparison and classification.

† ἄρχω, to overrule, and ἐγκέφαλος, brain.

terized is called 'MONOTREMATA,' in reference to the single excretory and generative outlet, which, however, is by no means peculiar to them among Mammalia. The Monotremes are insectivorous, and are strictly limited to Australia and Tasmania.

The MARSUPIALIA are Mammals distinguished by a peculiar pouch or duplicature of the abdominal integument, which in the males is everted, forming a pendulous bag containing the testes; and in the females is inverted, forming a hidden pouch containing the nipples and usually sheltering the young for a certain period after their birth: they have the marsupial bones in common with the Monotremes; a much-varied dentition, especially as regards the number of incisors, but usually including 4 true molars; and never more than 3 premolars:* the angle of the lower jaw is more or less inverted.†

With the exception of one genus, *Didelphys*, which is American, and another genus, *Cuscus*, which is Malayan, all the known existing Marsupials belong to Australia, Tasmania, and New Guinea. The grazing and browsing Kangaroos are rarely seen abroad in full daylight, save in dark rainy weather. Most of the Marsupialia are nocturnal. Zoological wanderers in Australia, viewing its plains and scanning its scrubs by broad daylight, are struck by the seeming absence of mammalian life; but during the brief twilight and dawn, or by the light of the moon, numerous forms are seen to emerge from their hiding-places and illustrate the variety of marsupial life with which many parts of the continent abound. We may associate with their low position in the mammalian scale the prevalent habit amongst the Marsupialia of limiting the exercise of the faculties of active life to the period when they are shielded by the obscurity of night.

The Lissencephala or smooth-brained Placentals form a group which I consider as equivalent to the Lyencephala or Implacentals; and which includes the following orders *Rodentia*, *Insectivora*, *Cheiroptera* and *Bruta*. The RODENTIA are characterized by two large and long curved incisors in each jaw, separated by a wide interval from the molars; and these teeth are so constructed, and the jaw is so articulated, as to serve in the reduction of the food to small particles by acts of rapid and continued gnawing, whence the name of the order. The orbits are not separated from the temporal fossæ. The testes pass periodically from the abdomen into a temporary scrotum, and are associated with prostatic and vesicular glands. The placenta is commonly discoid, but it is sometimes a circular mass (Cavy), or flattened and divided into three or more lobes (Lepus). The Beaver and

* "Outlines of a Classification of the Marsupialia," Trans. Zool. Soc., vol. ii, 1839.

† For other Osteological and Dental characteristics of the Marsupialia, see the paper above cited, and that "On the Osteology of the Marsupialia," Trans. Zool. Soc., vol. ii, p. 379 (1838).

Capybara are now the giants of the order, which chiefly consists of small, numerous, prolific and diversified unguiculate genera, subsisting wholly or in part on vegetable food. Some Rodents, *e. g.* the Leamings, perform remarkable migrations, the impulse to which, unchecked by danger or any surmountable obstacles, seems to be mechanical. Many Rodents build very artificial nests, and a few manifest their constructive instinct in association. In all these inferior psychical manifestations we are reminded of Birds. Many Rodents hibernate like Reptiles. They are distributed over all continents.

The transition from the Marsupials to the Rodents is made by the Wombats; and the transition from the Marsupials is made, by an equally easy step, through the smaller Opossums to the INSECTIVORA. This term is given to the order of small smooth-brained Mammals, the molar teeth of which are bristled with cusps, and are associated with canines and incisors: they are unguiculate, plantigrade, and pentadactyle, and they have complete clavicles. The testes pass periodically from the abdomen into a temporary scrotum, and are associated with large prostatic and vesicular glands: like most other *Lissencephala*, the Insectivora have a discoid or cup-shaped placenta. Their place and office in South America and Australia are fulfilled by Marsupialia; but true Insectivora exist in all the other continents.

The order CHEIROPTERA, with the exception of the modification of their digits for supporting the large webs that serve as wings, repeat the chief characters of the Insectivora; but a few of the larger species are frugivorous, and have corresponding modifications of the teeth and stomach. The mammæ are pectoral in position, and the penis is pendulous in all Cheiroptera. The most remarkable examples of periodically torpid Mammals are to be found in the terrestrial and volant Insectivora. The frugivorous Bats differ much in dentition from the true Cheiroptera, and would seem to conduct through the Colugos or Flying Lemurs, directly to the Quadrumanous order. The Cheiroptera are cosmopolitan.

The order BRUTA, called *Edentata* by Cuvier, includes two genera which are devoid of teeth; the rest possess those organs, which, however, have no true enamel, are never displaced by a second series, and are very rarely implanted in the premaxillary bones. All the species have very long and strong claws. The ischium as well as the ilium unites with the sacrum; the orbit is not divided from the temporal fossa. I have already adverted to the illustration of affinity to the oviparous Vertebrata which the Three-toed Sloths afford by the supernumerary cervical vertebræ supporting false ribs and by the convolution of the windpipe in the thorax; and I may add that the unusual number—three and

twenty pairs—of ribs, forming a very long dorsal, with a short lumbar, region of the spine in the Two-toed Sloth, recalls a lacertine structure. The same tendency to an inferior type is shown by the abdominal testes, the single cloacal outlet, the low cerebral development, the absence of medullary canals in the long bones in the Sloths, and by the great tenacity of life and long-enduring irritability of the muscular fibre, in both the Sloths and Ant-eaters.*

The order Bruta is but scantily represented at the present period. One genus *Manis* or Pangolin, is common to Asia and Africa; the *Orycteropus* is peculiar to South Africa; the rest of the order, consisting of the genera *Myrmecophaga*, or true Ant-eaters, *Dasypus* or Armadillos, and *Bradypus* or Sloths, are confined to South America.

Having defined the orders or subdivisions of the two foregoing subclasses, I may remark that the Lyencephala cannot be regarded as equivalent merely to one of the orders, say *Rodentia*, of the Lissencephala, without undervaluing the anatomical characters which are so remarkable and distinct in the marsupial and monotrematous animals. The anatomical peculiarities of the edentulous Lyencephala† appear to me to be, at least, of ordinal importance. In these deductions I hold the mean between those who, with Geoffroy St. Hilaire, would make of the *Monotremata* a distinct class of animals, or with De Blainville, a distinct subclass (*Ornithodelphes*) of Mammals,‡ and those who, with Cuvier, would make the Monotremes a mere family of the *Edentata*, or, with Mr. Waterhouse, a family of the *Marsupiata*.§ In like manner, whilst I regard the Lyencephala (*Marsupiata* of Waterhouse) as forming a group of higher rank than an order, I do not consider it as forming an equivalent primary group to that formed by all the placental Mammalia.

It appears to me that the true value of the Lyencephala or Implacentalia is that of one of four primary divisions or subclasses of the Mammalia; that its true equivalency is with the Lissencephala, and that all its analogical relations are to be found more truly in that smooth-brained subclass than in the Placentalia at large.

* This latter vital character attracted the notice of the earliest observers of these animals. Thus Marcgrave and Piso narrate of the Sloth:—"Cor motum suum validissimè retinebat, postquam exemptum erat e corpore per semihorium:—exempto corde cæteris visceribus, multò post se movebat et pedes lentè contrahebat sicut dormituriens solet.' Buffon, who quotes the above from the 'Historia Naturalis Brasiliæ,' p. 322, well remarks, "Par ces rapports, ce quadrupède se rapproche non seulement de la tortue, dont il a la lenteur, mais encore des autres reptiles et de tous ceux qui n'ont pas un centre du sentiment unique et bien distinct."—Hist. Naturelle, 4to, tom. xiii, p. 45.

† See my article *Monotremata*, in the Cyclopædia of Anatomy, part xxvi, 1841.

‡ Ostéographie, fascicule premier, 4to, 1839, p. 47.

§ Nat. Hist. of Mammalia, part i, 1845, p. 18.

The following table exemplifies the correspondence of the groups in the Lyencephalous and Lissencephalous series:—

Lyencephala.	Lissencephala.
*Rhizophaga**	Burrowing *Rodentia*.
*Poëphaga**	*Dipodidæ* and *Leporidæ*.
Petaurus	*Pteromys*.
Phalangistidæ	*Sciuridæ* and prehensile-tailed arboreal Rodents.
Phascolarctos	*Bradypus*.
Perameles and *Mymecobius*	*Erinaceidæ*.
Chæropus	*Macroscelis*.
Didelphys and *Phascogale*	*Soricidæ*.
Dasyuridæ	*Centetes*, *Gymnura*.
Echidna	*Manis*.
Ornithorhyncus	*Orycteropus*.

The classification proposed by M. Gervais, already cited (p. 179), in which the *Rodentia*, *Cheiroptera*, and *Insectivora* are associated in the same high primary group with the *Quadrumana* and *Bimana*, is avowedly adopted from that previously proposed by Prof. Milne Edwards.†

In next proceeding to consider the subdivisions of the Gyrencephala, we seem at first to descend in the scale in meeting with a group of animals in that subclass, having the form of fishes; but a high grade of mammalian organization is masked beneath this form. The Gyrencephala are primarily subdivided, according to modifications of the locomotive organs, into three series, for which the Linnean terms may well be retained; viz. *Mutilata*, *Ungulata* and *Unguiculata*, the maimed, the hoofed, and the clawed series.

These characters can only be applied to the Gyrencephalous subclass; *i. e.* they do not indicate natural groups, save in that section of the Mammalia. To associate the Lyencephala and Lissencephala with the unguiculate Gyrencephala into one great primary group, as in the Mammalian systems of Ray, Linnæus and Cuvier, is a misapplication of a solitary character akin to that which would have founded a primary division on the discoid placenta or the diphyodont dentition. No one has proposed to associate the unguiculate Bird or Lizard with the unguiculate Ape, and it is but a little less violation of natural affinities to associate the Monotremes with the Qaudrumanes in the same primary (unguiculate) division of the Mammalian class.

* See the "Classification of the Marsupialia," in the Zoological Transactions, vol. ii, p. 232.

† See note at p. 179.

The three primary divisions of the Gyrencephala are of higher value than the ordinal divisions of the Lissencephala; just as those orders are of higher value than the representative families of the Marsupials.

The *Mutilata*, or the maimed Mammals with folded brains, are so called because their hind-limbs seem, as it were, to have been amputated; they possess only the pectoral pair of limbs, and these in the form of fins: the hind end of the trunk expands into a broad, horizontally flattened, caudal fin. They have large brains with many and deep convolutions, and are naked, and have neither neck, scrotum, nor external ears.

The first order, called CETACEA, in this division are either edentulous or monophyodont, and with teeth of one kind and usually of simple form. They are testicond and have no 'vesiculæ seminales.' The mammæ are pudendal; the placenta is diffused; the external nostrils—single or double—are on the top of the head, and called spiracles or "blow-holes." They are marine, and, for the most part, range the unfathomable ocean; though with certain geographical limits as respects species. They feed on fishes or marine animals.

The second order, called SIRENIA, have teeth of different kinds, incisors which are preceded by milk-teeth, and molars with flattened or ridged crowns, adapted for vegetable food. The nostrils are two, situated at the upper part of the snout; the lips are beset with stiff bristles; the mammæ are pectoral; the testes are abdominal, as in the Cetacea, but are associated with vesiculæ seminales. The Sirenia exist near coasts or ascend large rivers, browsing on fuci, water plants or the grass of the shore. There is much in the organization of this order that indicates its affinity to members of the succeeding division.

In the *Ungulata* the four limbs are present, but that portion of the toe which touches the ground is incased in a hoof, which blunts its sensibility and deprives the foot of prehensile power. With the limbs restricted to support and locomotion, the Ungulata have no clavicles: the fore-leg remains constantly in the state of pronation, and they feed on vegetables.

A particular order, or suborder, of this group is indicated by certain South American genera, *e. g. Toxodon* and *Nesodon*,* with long, curved, rootless teeth, having a partial investment of enamel, and with certain peculiarities of cranial structure: the name TOXODONTIA is proposed for this order, all the representatives of which are extinct.

A second remarkable order, most of the members of which have, also, passed away, is characterized by two incisors in the form of long tusks; in one genus (*Dinotherium*) projecting from

* Philosophical Transactions, 1853, p. 291.

the under jaw, in another genus (*Elephas*) from the upper jaw, and in some of the species of a third genus (*Mastodon*), from both jaws. There are no canines; the molars are few, large and transversely ridged; the ridges sometimes few and mammillate, often numerous and with every intermediate gradation. The nose is prolonged into a cylindrical trunk, flexible in all directions, highly sensitive, and terminated by a prehensile appendage like a finger: on this organ is founded the name PROBOSCIDIA given to the order. The feet are pentadactyle, but are indicated only by divisions of the hoof; the testes are abdominal; the placenta is annular;* the mammæ are pectoral.

Both the present and preceding orders of *Ungulata* may be called aberrant: the dentition of the Toxodon, and several particulars of the organization of the Elephant, indicate an affinity to the Rodentia; the cranium of the Toxodon, like that of the Dinothere, resembles that of the Sirenia in its remarkable modifications.

The typical Ungulate quadrupeds are divided, according to the odd or even number of the toes, into PERISSODACTYLA and ARTIODACTYLA.† In the perissodactyle or odd-toed Ungulata—odd-toed at least in regard to the hind-foot,—the dorso-lumbar vertebræ differ in number in different species, but are never fewer than twenty-two; the femur has a third trochanter; and the medullary artery does not penetrate the fore-part of its shaft. The fore-part of the astragalus is divided into two very unequal facets. The os magnum and the digitus medius which it supports are large, in some disproportionately so, and the digit is symmetrical: the same applies to the ectocuneiform and the digit which it supports in the hind-foot. If the species be horned, the horn is single; or, if there be two, they are placed on the median line of the head, one behind the other, each being thus an odd horn. The nasals expand posteriorly. There is a well-developed post-tympanic process which is separated by the true mastoid from the paroccipital in the Horse, but unites with the lower part of the paroccipital in the Tapir, and seems to take the place of the mastoid in the Rhinoceros and Hyrax. The hinder half, or a larger proportion, of the palatines enters into the formation of the posterior nares, the oblique aperture of which commences in advance either of the last molar, or, as in most, of the penultimate one. The pterygoid process has a broad and thick base, and is perforated lengthwise by the ectocarotid. The crown of from one to three of the hinder premolars is as

* Besides the annular placenta there is a subcircular villous patch at each pole of the chorionic bag, by which it derived additional attachment to the uterus, in the Elephant.

† From *περισσοδάκτυλος*, qui digitos habet impares numero; and *ἄρτιος*, par *δάκτυλος*, digitus.

complex as those of the molars:* that of the last lower milk-molar is commonly bilobed. To these osteological and dental characters may be added some important modifications of internal structure, as, *e. g.* the simple form of the stomach and the capacious and sacculated cæcum, which equally evince the mutual affinities of the odd-toed or perissodactyle hoofed quadrupeds, and their claims to be regarded as a natural group of the *Ungulata*. The placenta is replaced by a diffused vascular villosity of the chorion in all the recent genera of this order, excepting the little *Hyrax*, in which there is a localised annular placenta, as in the Elephant. But the diffused placenta occurs in some genera of the next group, showing the inapplicability of that character to exact classification. Many extinct genera, *e. g. Coryphodon*, *Pliolophus*, *Lophiodon*, *Tapirotherium*, *Palæotherium*, *Ancitherium*, *Hipparion*, *Acerotherium*, *Elasmotherium*, &c., have been discovered, which once linked together the now broken series of Perissodactyles, represented by the existing genera *Rhinoceros*, *Hyrax*, *Tapirus*, and *Equus*.

In the even-toed or 'artiodactyle' Ungulates, the number of the dorso-lumbar vertebræ is the same, as a general rule, in all the species, being nineteen. The recognition of this important character appears to have been impeded by the variable number of moveable ribs in different species of the Artiodactyles, the dorsal vertebræ, which those ribs characterize, being fifteen in the Hippopotamus and twelve in the Camel. And the value of this distinction has been exaggerated owing to the common conception of the ribs as special bones distinct from the vertebræ, and their non-recognition as parts of a vertebra equivalent to the neurapophyses and other autogenous elements. The vertebral formulæ of the Artiodactyle skeletons show that the difference in the number of the so-called dorsal and lumbar vertebræ does not affect the number of the entire dorso-lumbar series: thus, the Indian Wild Boar has *d.* 13, *l.* 6=19; the Domestic Hog and the Peccari have *d.* 14, *l.* 5=19; the Hippopotamus has *d.* 15, *l.* 4=19; the Gnu and Aurochs have *d.* 14, *l.* 5=19; the Ox and most of the true Ruminants have *d.* 13, *l.* 6=19; the aberrant Ruminants have *d.* 12, *l.* 7=19. The natural character and true affinities of the Artiodactyle group are further illustrated by the absence of the third trochanter in the femur, and by the place of perforation of the medullary artery at the fore and upper part of the shaft, as in the Hippopotamus, the Hog, and most of the Ruminants. The fore part of the astragalus is divided into two equal or sub-equal facets: the os magnum does not exceed, or is less than, the unciforme in size, in the carpus; and the ectocuneiform is less, or not larger, than the cuboid, in the tarsus.

* The extinct Lophiodonts form the sole known exception to this rule.

The digit answering to the third in the pentadactyle foot is unsymmetrical, and forms, with that answering to the fourth, a symmetrical pair. If the species be horned, the horns form one pair or two pairs; they are never developed singly, of symmetrical form, from the median line. The post-tympanic does not project downward distinctly from the mastoid, nor surpersede it in any Artiodactyle; and the paroccipital always exceeds both those processes in length. The bony palate extends farther back than in the Perissodactyles; the hinder aperture of the nasal passages is more vertical and commences posterior to the last molar tooth. The base of the pterygoid process is not perforated by the ectocarotid artery. The crowns of the premolars are smaller and less complex than those of the true molars, usually representing half of such crown. The last milk-molar is trilobed.

To these osteological and dental characters may be added some important modifications of internal structure, as, *e. g.* the complex form of the stomach in the Hippopotamus, Peccari, and Ruminants; the comparatively small and simple cæcum and the spirally folded colon in all Artiodactyles, which equally indicate the mutual affinities of the even-toed hoofed quadrupeds, and their claims to be regarded as a natural group of the *Ungulata*. The placenta is diffused in the Camel-tribe and non-ruminants; is cotyledonal in the true Ruminants. Many extinct genera, *e. g. Chæropotamus*, *Anthracotherium*, *Hyopotamus*, *Entelodon*, *Dichodon*, *Merycopotamus*, *Xiphodon*, *Dichobune*, *Anoplotherium*, *Microtherium*, &c., have been discovered, which once linked together the now broken series of Artiodactyles, represented by the existing genera, *Hippopotamus*, *Sus*, *Dicotyles*, *Camelus*, *Auchenia*, *Moschus*, *Camelopardalis*, *Cervus*, *Antilope*, *Ovis*, and *Bos*.

A well-marked, and at the present day, very extensive subordinate group of the Artiodactyles, is called *Ruminantia*, in reference to the second mastication to which the food is subject after having been swallowed; the act of rumination requiring a peculiarly complicated form of stomach. The Ruminants have the 'cloven foot,' *i. e.* two-hoofed digits on each foot forming a symmetrical pair, as by the cleavage of a single hoof; in most species two small supplementary hoofed toes are added. The metacarpals of the two functional toes coalesce to form a single 'cannon-bone,' as do the corresponding metatarsals. The Camel-tribe have the upper incisors reduced to a single pair; in the rest of the Ruminants the upper incisors are replaced by a callous pad. The lower canines are contiguous, and, save, in the Camel-tribe, similar to the six lower incisors, forming part of the same terminal series of eight teeth, between which and the molar series there is a wide interval. The true molars have their grinding surface marked by two double crescents, the convexity

of which is turned inwards in the upper and outwards in the under jaw.

Many fossil Artiodactyles, with similar molars, appear to have differed from the Ruminants chiefly by retaining structures which are transitory and embryonic in most existing Ruminants, as, *e. g.*, upper incisors and canines,* first premolars, and separate metacarpal and metatarsal bones; these are among the lost links that once connected more intimately the Ruminants with the Hog and Hippopotamus.

The Pachyderms in the Cuvierian system included all the non-ruminant hoofed beasts; they were divided by the great French anatomist into the *Proboscidia*, *Solidungula*, and *Pachydermata ordinaria*, the latter again being subdivided according to the odd or even number of the hoofs. I have on another occasion† adduced evidence to show that the right progression of the affinities of the *Ungulata* was broken by the interposition of the Horse and other Perissodactyles between the non-ruminant or omnivorous and ruminant Artiodactyles; and that too high a value had been assigned to the Ruminantia by making them equivalent to all the other Ungulates collectively.‡

The third division of the *Gyrencephala* enjoy a higher degree of the sense of touch through the greater number and mobility of the digits, and the smaller extent to which they are covered

* In a new-born Dromedary (*Camelus Dromedarius*, L.), which perished in the birth at the London Zoological Gardens, the following was the state of the dentition. In the upper jaw there were six deciduous incisors (3—3), which were calcified, and presented a larger proportional size than any rudiments of those teeth that have been noticed in ordinary Ruminants, and they leave conspicuous alveoli in the præmaxillaries: the deciduous canine and first functional milk-molar (*d.* 2) were small, the latter with a simple crown; the second (*d.* 3) and third (*d.* 4) molars were large, bilobed, and each lobe was bicrescentic. In the lower jaw the six incisors and two canines form a semicircular series of nearly equal teeth, with overlapping leaf-shaped crowns, the deciduous canines more resembling the incisors than the permanent ones do: the functional molars are but two in number, on each side; the first is small, simple, conical, compressed, notched behind; the second is very large and three-lobed, each lobe being bicrescentic, and the last the largest. Only the summits of the crescents of the molar teeth had pierced the gum (Catal. of Osteology, Mus. Roy. Coll. of Surgeons, vol. ii, p. 577, 4to, 1853).

† Quarterly Journal of the Geological Society, December, 1847.

‡ Since the communication of my paper on the classification and affinities of the hoofed animals to the Geological Society, Nov. 3, 1847, in which the grounds for the division of the *Ungulata* into two orders, according to the parity or imparity of the digits, as proposed in my 'Odontography,' are given in detail, the idea has been ventilated and more or less adopted by M. Pomel (Comptes Rendus de l'Acad. des Sciences, June 19, 1848), and by M. Gervais (Zoologie et Paléontologie Française, p. 42). The latter experienced palæontologist, extending the term 'Pachydermes' to include all the Ungulates, divides them into 'Pachydermes herbivores' and 'Pachydermes omnivores,' respectively equivalent to my *Perissodactyla* and *Artiodactyla*, which latter terms M. Pomel adopts. M. Gervais writes: "Les pachydermes omnivores se lient d'une manière si intime aux Ruminants par les Chevrotains et les Chameaux, qu'il est devenu impossible de séparer, comme ordre différent de celui des Ruminants l'ensemble de ces Pachydermes, autrefois confondus avec les Pachydermes herbivores."—*Op. cit.*, Expl. de Planche, xxxvi, p. 6, 4to, 1854.

by horny matter. This substance forms a single plate, in the shape of a claw or nail, which is applied to only one of the surfaces of the extremity of the digit, leaving the other, usually the lower, surface possessed of its tactile faculty; whence the name *Unguiculata*, applied to this group, which, however, is more restricted and natural than the group to which Linnæus extended the term. All the species are 'diphyodont,' and the teeth have a simple investment of enamel.

The first order, CARNIVORA, includes the beasts of prey, properly so called. With the exception of a few Seals, the incisors are $\frac{3-3}{3-3}$ in number; the canines $\frac{1-1}{1-1}$, always longer than the other teeth, and usually exhibiting a full and perfect development as lethal weapons; the molars graduate from a trenchant to a tuberculate form, in proportion as the diet deviates from one strictly of flesh to one of a more miscellaneous kind. The clavicle is rudimental or absent; the innermost digit is often rudimental or absent; they have no vesiculæ seminales: the teats are abdominal; the placenta is zonular. The Carnivora are divided, according to modifications of the limbs, into 'Pinnigrades,' 'Plantigrades,' and 'Digitigrades.' In the Pinnigrades (Walrus, Seal-tribe) both fore and hind feet are short, and expanded into broad webbed paddles for swimming, the hinder ones being fettered by continuation of integument to the tail. In the Plantigrades (Bear-tribe) the whole or nearly the whole of the hind foot forms a sole, and rests on the ground. In the Digitigrades (Cat-tribe, Dog-tribe, &c.) only the toes touch the ground, the heel being much raised.

It has been usual to place the Plantigrades at the head of the Carnivora, apparently because the higher order, Quadrumana, is plantigrade; but the affinities of the Bear, as evidenced by internal structure, *e. g.*, the renal and genital organs, are closer to the Seal-tribe;* the broader and flatter pentadactyle foot of the plantigrade is nearer in form to the flipper of the Seal than is the more perfect digitigrade, retractile-clawed, long and narrow hind foot of the feline quadruped, which is the highest and most typical of the Carnivora.

The next perfection which is superinduced upon the unguiculate limb is such a modification in the size, shape, position, and direction of the innermost digit, that it can be opposed, as a thumb, to the other digits, thus constituting what is properly termed a 'hand.' Those Unguiculates which have both fore

* 'Catalogue of the Physiological Series,' Mus. R. Coll. of Surgeons, 4to, vol. ii, 1834, p. 127. Mr. Waterhouse, in noticing the projecting process on the under side of the ramus, a little in advance of the angle of the lower jaw in the *Ursidæ*, remarks:—"The same character is also found in many Seals (*Phocidæ*), which in several other respects appear to approach the bears."—Proc. Zool. Soc., Sept. 1839.

and hind limbs so modified, or at least the hind limbs, form the order QUADRUMANA. They have $\frac{2-2}{2-2}$ incisors,* and $\frac{3-3}{3-3}$ broad tuberculate molars;† perfect clavicles, pectoral mammæ, vesicular and prostatic glands, a simple or slightly bifid uterus, and a discoid, sometimes double, placenta.‡ The Quadrumana have a well-marked threefold geographical as well as structural division. The Strepsirhines are those with curved or twisted terminal nostrils, with much modified incisors, commonly $\frac{3-3}{3-3}$; premolars $\frac{3-3}{3-3}$ or $\frac{2-2}{2-2}$ in number, and molars with sharp tubercles; the second digit of the hind limb has a claw. This group includes the Galagos, Pottos, Aye-Ayes, Loris, Indris, and the true Lemurs; the three latter being restricted to Madagascar, whence the group diverges in one direction to the continent of Africa, in the other to the Indian Archipelago. The Platyrhines are those with the nostrils subterminal and wide apart; premolars $\frac{3-3}{3-3}$ in number, the molars with blunt tubercles; the thumbs of the fore-hands not opposable or wanting; the tail in most prehensile; they are peculiar to South America. The Catarhines have the nostrils oblique and approximated below, and opening above and behind the muzzle: the premolars are $\frac{2-2}{2-2}$ in number; the thumb of the fore-hand is opposable. They are restricted to the Old World, and, save a single species on the rock of Gibraltar, to Africa and Asia. The highest organized family of Catarhines is tailless, and offers in the Orang and Chimpanzee the nearest approach to the human type.

The structural modifications in the genus *Homo*,—the sole representative of the *Archencephala*,—more especially of the lower limb, by which the erect stature and bipedal gait are maintained, are such as to claim for MAN ordinal distinction on merely external zoological characters. But as I have already argued, his psychological powers, in association with his extraordinarily developed brain, entitle the group which he represents to equivalent rank with the other primary divisions of the class *Mammalia* founded on cerebral characters. In this primary group Man forms but one genus, *Homo*, and that genus but one order, called BIMANA, on account of the opposable thumb being restricted to the upper pair of limbs. The testes are scrotal; their serous sac does not communicate with the abdomen; they are associated with vesicular and prostatic glands. The penis is pendulous,

* With few exceptions in the anomalous *Lemuridæ*.

† Reduced to $\frac{2-2}{2-2}$ in the Marmosets (*Hapale*, *Mydas*).

‡ Among the Platyrhines, the placenta is single in *Mycetes*, double in *Callithrix*: among the Catarhines, the placenta is double in *Macacus*, *Cercopithecus*, and *Semnopithecus*, single in *Troglodytes*.

and the prepuce has a frænum. The mammæ are pectoral. The placenta is a single, subcircular, cellulo-vascular, discoid body.

Man has only a partial covering of hair, which is not merely protective of the head, but is ornamental and distinctive of sex. The dentition of the genus *Homo* is reduced to thirty-two teeth by the suppression of the outer incisor and the first two premolars of the typical series on each side of both jaws, the dental formula being :—

$$i.\ \frac{2-2}{2-2},\quad c.\ \frac{1-1}{1-1},\quad p.\ \frac{2-2}{2-2},\quad m.\ \frac{3-3}{3-3} = 32.$$

All the teeth are of equal length, and there is no break in the series; they are subservient in Man not only to alimentation, but to beauty and to speech.

The human foot is broad, plantigrade, with the sole, not inverted as in *Quadrumana*, but applied flat to the ground; the leg bears vertically on the foot; the heel is expanded beneath; the toes are short, but with the innermost longer and much larger than the rest, forming a 'hallux' or great toe, which is placed on the same line with, and cannot be opposed to, the other toes; the pelvis is short, broad and wide, keeping well apart the thighs; and the neck of the femur is long, and forms an open angle with the shaft, increasing the basis of support for the trunk. The whole vertebral column, with its slight alternate curves, and the well-poised, short, but capacious subglobular skull, are in like harmony with the requirements of the erect position. The widely-separated shoulders, with broad scapulæ and complete clavicles, give a favorable position to the upper limbs, now liberated from the service of locomotion, with complex joints for rotary as well as flexile movements, and terminated by a hand of matchless perfection of structure, the fit instrument for executing the behests of a rational intelligence and a free will. Hereby, though naked, Man can clothe himself, and rival all native vestments in warmth and beauty; though defenceless, Man can arm himself with every variety of weapon, and become the most terribly destructive of animals. Thus he fulfills his destiny as the supreme master of this earth, and of the lower Creation.

In these endeavors to comprehend how Nature has associated together her mammalian forms, the weary student quits his task with a conviction that, after all, he has been rewarded with but an imperfect view of such natural association. The mammalian class has existed, probably from the triassic, certainly from the lower oolitic period; and has changed its generic and specific forms more than once in the long lapse of ages, during which life-work has been transacted on this planet by animals of that

high grade of organization. Not any of the mammalian genera of the secondary periods occur in the tertiary ones. No genus found in the older eocenes (plastic and septarial clays, &c.) has been discovered in the newer eocenes. Extremely few eocene genera occur in miocene strata, and none in the pliocene. Many miocene genera of Mammalia are peculiar to that division of the tertiary series. Species indistinguishable from existing ones begin to appear only in the newer pliocene beds. Whilst some groups, as, *e. g.*, the Perissodactyles and omnivorous Artiodactyles, have been gradually dying out, other groups, as, *e. g.*, the true Ruminants, have been augmenting in genera and species.

In many existing genera of different orders there is a more specialized structure, a greater deviation from the general type, than in the answering genera of the miocene and eocene periods; such later and less typical Mammalia do more effective work by their more adaptively modified structures. The Ruminants, *e. g.*, more effectually digest and assimilate grass, and form out of it a more nutritive and sapid kind of meat, than did the antecedent more typical or less specialized non-ruminant Herbivora.

The monodactyle Horse is a better and swifter beast of draught and burthen than its tridactyle predecessor the miocene *Hipparion* could have been. The nearer to a Tapir or a Rhinoceros in structure, the further will an equine animal be left from the goal in contending with a modern Racer. The genera *Felis* and *Machærodus*, with their curtailed and otherwise modified dentition and short strong jaws, become, thereby, more powerfully and effectively destructive than the eocene *Hyænodon* with its typical dentition and three carnassial teeth on each side of its concomitantly prolonged jaws could have been.

Much additional and much truer insight has, doubtless, been gained into the natural grouping of the Mammalia since palæontology has expanded our survey of the class; but our best characterized groups do but reflect certain mental conceptions, which must necessarily relate to incomplete knowledge, and that as acquired at a given period of time. Thus the order which Cuvier deemed the most natural one in the class *Mammalia* becomes the debris of a group, known at a subsequent period to be a more natural order.

We cannot avoid recognizing, in the scheme which I now submit, the inequality which reigns amongst the groups, which our present anatomical knowledge leads us to place in one line or parallel series as orders. I do not mean mere inequality as respects the number and variety of the families, genera, and species of such orders, because the paucity or multitude of instances manifesting a given modification or grade of structure in no essential degree affects the value of such grade or modification.

The order *Monotremata* is not the less ordinarily distinct from the *Marsupialia*, because it consists of but two genera, than is the order *Bimana* from that of *Quadrumana*, because it includes only a single genus. So likewise the anatomical peculiarities of the *Proboscidia*, *Sirenia*, and *Toxodontia* call, at least, for those general terms, to admit of the convenient expression of general propositions respecting them; and some of these general propositions are of a value as great as the organic characters of more expanded orders.

There are residuary or aberrant forms in some of the orders, which, to the systematist disagreeably, compel modifications of the characters that would apply to the majority of such orders. The flying Lemurs (*Galeopitheci*), the rodent Lemurs (*Cheiromys*), the slow Lemurs (*Loris*, *Otolicnus*), forbid any generalization as to teeth or nails in the *Quadrumana*, whilst they continue associated with that order by the character of the hinder thumb; which, by the way, they possess in common with the pedimanous Marsupials. The large, volant, frugivorous Bats (*Pteropus*) are equally opposed to the application of a common dental character to the *Cheiroptera*. They are associated with the insectivorous Bats on account of the common external form arising out of the modification of their locomotive organs for flight, just as the Dugongs and Manatees are associated with the *Cetacea* on account of their resemblance to Fishes arising out of the same modification of the locomotive system for an aquatic existence. The herbivorous *Cetacea* are now separated from the piscivorous *Cetacea* as a distinct order; and with almost as good reason we might separate the frugivorous from the insectivorous *Cheiroptera;* the cases are very nearly parallel.

Nature, in short, is not so rigid a systematist as Man. There are peculiar conditions of existence which she is pleased shall be enjoyed by peculiarly modified mammals; these peculiarities break through the rules of structure which govern the majority of species existing and subsisting under the more general conditions of existence, to which the larger groups of Mammalia are respectively adjusted.

One class of organs seems to govern one order, another class another order; the dental system, which is so diversified in the *Marsupialia* and *Bruta*, is as remarkable for its degree of constancy in the *Rodentia* and *Insectivora*. But, as a general rule, the characters from the dental, locomotive and placental systems are more closely correlated in the Gyrencephalous orders than in those in the inferior subclasses of the Mammalia.

In the subjoined tabular view of the classification of the Mammalia, the groups below the ranks of orders are inserted merely as illustrations of those orders, not as equivalent subdivisions, or as the most natural subdivisions of those orders, into which it has not been the aim of the present paper to enter.

Table of the Subclasses and Orders of the Mammalia.

Class.	Subclass.		Order.	
MAMMALIA	Archencephala *		Bimana	*Homo.*
	Gyrencephala †	Unguiculata	Quadrumana	*Catarrhina.*
				Platyrrhina.
				Strepsirhina.
			Carnivora	*Digitigrada.*
				Plantigrada.
				Pinnigrada.
		Ungulata	Artiodactyla	*Omnivora.*
				Ruminantia.
			Perissodactyla	*Solidungula.*
				Multungula.
			Proboscidia	*Elephas.*
				Dinotherium.
			Toxodontia	*Toxodon.*
				Nesodon.
		Mutilata	Sirenia	*Manatus.*
				Halicore.
			Cetacea	*Delphinidæ.*
				Balænidæ.
	Lissencephala ‡		Bruta	*Bradypodidæ.*
				Dasypodidæ.
				Edentula.
			Cheiroptera	*Frugivora.*
				Insectivora.
			Insectivora	*Talpidæ.*
				Erinaceidæ.
				Soricidæ.
			Rodentia	*Non-claviculata.*
				Claviculata.
	Lyencephala §		Marsupialia	*Rhizophaga.*
				Poëphaga.
				Carpophaga.
				Entomophaga.
			Monotremata	*Echidna.*
				Ornithorhynchus.

Art. XVIII.—*On Chalcodite;* by George J. Brush.

The name Chalcodite was proposed‖ in 1851 by Prof. C. U. Shepard, for a mineral which occurs at Sterling, N. Y., which had previously been referred to Cacoxene by Beck.¶ Prof. Shepard's analysis showed the mineral to be a hydrous silicate of iron and magnesia. More recently, Prof. Shepard has published** an analysis made by Dr. Mallet which gave the composition:

Si 39·77, Fe 40·84, Mn *tr.*, Al 8·52, Ca 5·98, Mg 1·97, H 5·51 = 102·59,

part of the lime was supposed to be as carbonate and probably

* ἄρχω, to over-rule, ἐγκέφαλος, the brain.

† γυρόω, to wind about, ἐγκέφαλος.

‡ λισσός, smooth, ἐγκέφαλος. § λύω, to loose, ἐγκέφαλος.

‖ Report Proc. 6th meeting Am. Assoc. Ad. Sci., p. 232.

¶ Beck's Mineralogy of New York, p. 402.

** Shepard's Min., 3d edition, p. iii.

a small portion of the iron existed as sesquioxyd. Dr. Mallet also communicated his results to Prof. Dana* with the remark that he had too little of the mineral for a satisfactory examination, and that the results of his analysis could hardly be depended upon for even a probable formula.

During the past summer I have had an opportunity of examining this mineral at its locality in Sterling, and from the specimens there collected I have obtained the following physical and chemical characters:—

The mineral generally occurs as a thin velvety coating on specular iron; occasionally it is disseminated through calcite, and not unfrequently it is implanted on quartz in small radiated hemispherical masses. Its structure is sometimes radiated but usually the coatings are made up of an aggregate of minute scales; the surface of the coatings often presents crystalline plates, not however, sufficiently well marked to determine the crystalline form. The scales are translucent. Cleavage very distinct in one direction, eminently micaceous.

There are two varieties of the mineral, one has a green color inclining to bronze, while the other has more of a yellow color, and strongly resembles *aurum musivum*. Streak olive-green to yellow. The lustre of both varieties is submetallic. Hardness =1. Sp. gr. =2·76 (at 16° C.).

Before the blowpipe in the closed tube, gives off water; the green variety is changed to a brown or yellow color; the color of the yellow variety darkens on heating and yields the same product as the green. In the forceps it fuses readily in both the oxydizing and reducing flames to a black glass; on charcoal fuses to a magnetic bead; dissolves in borax giving an iron reaction; with soda and nitre shows a trace of manganese; with salt of phosphorus gives reactions for both iron and silica.

I was unable to get enough of the lighter colored variety for an analysis in the wet way, but of the green variety I was fortunate in obtaining through the kindness of Dr. George N. Hubbard of Natural Bridge, N. Y., a specimen in which the Chalcodite formed rectangular crystals of more than half an inch in length, by a quarter of an inch in breadth, and about half a line in thickness. These crystals are evidently pseudomorphs, but the angles are so rounded that it is hardly possible to determine to what species they belong. The mineral forming these crystals is perfectly fresh and unaltered, the exterior of the crystals appears drusy, while interiorly they seem to be made up of minute and irregularly disposed scales. The pulverized mineral is decomposed by hydrochloric acid without gelatinizing; a qualitative analysis showed the presence of silica, alumina, protoxyd

* This Journal, vol. xxiv, p. 113

and sesquioxyd of iron and magnesia, with traces of manganese and lime.

In the quantitative examination in No. 1, the mineral was decomposed by hydrochloric acid, the iron and alumina weighed together and subsequently separated by potash. In No. 2 the water was determined directly by ignition in a stream of dry air and collecting the vapor in a chlorid of calcium tube. The ignited mass was found to be no longer decomposable by hydrochloric acid, and was accordingly fused with carbonate of soda. The iron and alumina were weighed together and the iron afterwards determined volumetrically, by means of permanganate of potash. For the determination of the protoxyd and sesquioxyd of iron as given in Nos. 3 and 4, portions of the mineral were dissolved in pure hydrochloric acid in a stream of carbonic acid gas, and the amount of protoxyd determined volumetrically as in No. 2. The whole of the iron was then reduced to the state of protoxyd by sulphuretted hydrogen gas, the solution boiled to expel the sulphuretted hydrogen, allowed to cool free from access of air and the whole amount of iron determined, the difference between which and the amount of protoxyd first obtained gives the amount existing as sesquioxyd.

The results of the analyses are as follows:—

	1.	2.	3.	4.
Quantity taken in milligr'ms,	435	591	338	217
Silica,	45·06	45·51	....	....
Alumina,	3·56	3·68	....	....
Sesquioxyd of iron,	38·85	38·61	20·92	20·02
Protoxyd of iron,	....	....	16·04	16·91
" of manganese,	*trace.*	*trace.*	....	....
Lime,	*trace.*	0·28	....	....
Magnesia,	4·55	4·57	....	....
Potash and Soda,	*trace.*	....	....	....
Water,	....	9·22	....	....

The mean of these analyses gives:—

		Oxygen.		Ratio.
$\ddot{S}i$	45·29	23·53	23·53	3
$\dot{A}l$	3·62	1·69	7·82	1
$\dot{F}e$	20·47	6·14		
$\dot{F}e$	16·47	3·66	5·56	$\frac{3}{4}$
$\dot{M}n$	*trace.*	....		
$\dot{C}a$	0·28	·08		
$\dot{M}g$	4·56	1·82		
$\dot{N}a, \dot{K}$	*trace.*	....	....	
$\dot{H}$	9·22	8·18	8·18	1
	99·91			

This ratio gives a formula which may be expressed by

$$2\dot{R}\,\ddot{S}i + \dot{R}\,\ddot{S}i + 3\dot{H}.$$

This composition approaches that given by Rammelsberg,* (analyses 1, 2, 3, and 4,) and Siegert,† (analysis 5,) for Stilpnomelane:

	Si	Al	Fe	Fe	Mg	Ca	K, Na	H	
1.	43·19	8·16	....	37·05	3·34	1·19	....	5·95	From Obergrund, near Zuckmantel in Austrian Silesia.
2.	46·50	7·19	....	33·89	1·89	0·20	....	7·90	
3.	45·43	5·88	....	35·38	1·68	0·18	....	9·28	
4.	46·17	5·88	....	35·82	2·67	....	0·75	8·72	
5.	42·07	4·92	41·98	....	0·94	1·67	....	8·47	From Weilburg in Nassau.

Siegert assumes the iron to exist as sesquioxyd while Rammelsberg gives it as protoxyd, with the remark that if it be calculated as Fe Fe, the analyses will give an excess, and therefore *perhaps* it only exists as protoxyd in the mineral.

It is evident from the results of analyses 1 to 4 that the stilpnomelane analyzed was not entirely free from foreign substances, and Rammelsberg mentions that it may possibly have been mixed with some chlorite, and that this is the reason for the difference in the results.

Analyses 3 and 4 correspond very closely with the analysis of chalcodite, and it is possible that if a special examination were made to determine the proportionate amounts of protoxyd and sesquioxyd of iron in stilpnomelane, the two minerals might be found even more nearly related.

The fact that stilpnomelane is but imperfectly decomposed by acids, while chalcodite is entirely decomposed, may be due to the extreme delicacy of the scales in the latter; the same cause will account for the difference in hardness. The specific gravity is 3·0—3·4 Glocker, or according to a more recent determination by Breithaupt, 2·769. Chalcodite has a density of 2·76. Stilpnomelane occurs both foliated and compact; its color is blackish-green, streak olive-green to greenish-gray; it has a pearly lustre and a perfect cleavage in one direction. A specimen from the Weilburg locality which I have in my cabinet bears a very strong resemblance to the green variety of chalcodite in its external appearance.

The marked similarity in chemical, as well as in many of the physical characters of these two minerals renders it not improbable that a reëxamination of pure stilpnomelane would remove those discrepancies which at present prevent their being united under one species.

Yale Analytical Laboratory, Dec. 15, 1857.

* Poggend. Ann., xliii, 127.

† Rammelsberg, Mineralogie, Fifth Suppl., 203.

Art. XIX.—*Agassiz's Contributions to the Natural History of the United States.*

The publication of the first two volumes of the "Contributions to the Natural History of the United States" by Professor Agassiz was announced in our last number, and a statement, in brief, made of their contents. The philosophical merits of the work, as well as its national character, entitle it to a more detailed notice.

While the special subject in American zoology selected for the volumes is the Embryology of Turtles, the first of the two is mainly occupied with general considerations on the system in the kingdoms of life—a topic of wide import to science, making an appropriate introduction to the great work.

These opening chapters have also a peculiar interest for the sketch they indirectly give of the author. Deep topics in science occupy his thoughts. But through all, appears that love of truth, which is the living force of a philosopher; that faith in nature as God's work, which gives to science its highest dignity; that desire to read the minutest tracings in the great volume, which the knowledge that all the grandeur of creation is brought out through infinitesimals, naturally inspires; that sensitiveness of mental organization which perceives the faintest voices of nature, and thrills to the profound harmonies in which those voices combine to utter the deep thoughts of creation. These qualities all shine forth from the pages as they could not from any portrait or biography.

A successful searching out of nature's laws requires faith in the fullness of the revelation, and in finite mind as the interpreter. This faith, moreover, should be coupled with a profound sense of nature's oneness in law, purpose and Author. The mind should also be open to the slightest breath of truth from whatever source, quick in its perceptions of parallelisms and analogies, and just in balancing fact against fact, relation against relation, so that all shall take their true position, and evolve, from their mutual action, the thought of which nature, not the mind, is the author. It is true that complete perfection of action is not human: for minds almost necessarily run in channels that limit their thoughts and vision; they are apt to be drawn aside by the delight of special views, and too often seek novelty and self-exaltation in place of truth: and all systems of philosophy suffer more or less from these sources of evil. He is the true student of nature, although thus imperfect, who seeks that nature should speak through him, and strives to express the sentiments that come forth at her dictation. And far profounder is his apprehension of truth when he realizes, in all its significance, that an

Infinite Spirit—infinitely good, just and wise—speaks through nature to man's heart as well as mind. Only a short-sighted naturalist fails to perceive that the affections and moral sentiments, in their perfection, are among the creations, and that preëminently they manifest the character of the Creator.

In striking contrast with the searching philosopher is the one who stands aside and doubts research, while he dictates self-wrought thoughts. Professor Agassiz, in several of his chapters, points his forcible argument against such a one—a distinguished physicist of Oxford, England. Neither geology nor zoology has discovered a foundation for the principle that species pass into other species by gradual change: but *he* says *perhaps* they do in the course of a great length of time. Geology has not detected the smallest fact to sustain the so-called development theory: but he says, perhaps it is still true. And then he goes on to propound his views, building up his theories on the basis of a *perhaps*, itself baseless, in direct opposition to the inductive system of philosophy which he would sustain.* So we find others, instead of taking the facts as they are known, and deriving from them the impression they are calculated to make and the laws they dictate, saying, *perhaps* geology in the end will find the past very much like the present, with no system of progress in the life of the globe;—while they cannot go from case to case in a cabinet illustrating this life according to the ages, without seeing the progression at every step. The mind becomes smothered under a *perhaps*, and rests in darkness and doubt, instead of coming out to the light and using it. Such men have their place, for they are checks on hasty theorizing; while the mere theorist that defies or disregards nature, is only following his own torch-light to error. As all our knowledge of nature's laws rests upon inductive reasoning, a mind that will doubt the

* There was doubt in many minds when the "Vestiges of Creation" was first published, whether such a development theory might not be true. But the facts exactly interpreted were soon found to be against it, and every year has added to the force of the demonstration. The sweeping destructions of species in geology have shown that there was a Creative Power that could reinstate the life of a continent without going back to the Monad. The N. American continent gives a striking example of such a destruction in the catastrophe which swept off Palæozoic life, and was followed here by not a single old species or peculiarly Palæozoic genus, but by the reptiles and birds of the Triassic or Jurassic. These facts and the actual independence of species, according to both geology and zoology, so stand before the scientific world at the present time, that the inductive philosopher must wait for new revelations from science, before he can, in the spirit of his philosophy, propound any such development theory. Let him study out facts respecting variations of species and find a basis to stand upon, and then he may march safely to his conclusions; and this is a great subject for study. But to push forward the view in advance of the facts, and *against* the present array of facts, is indulging in deluding speculation. Let him bring out his law, as a result of study, and tell us, what species of ox or other Ungulate was developed into a mastodon, or how the mastodon was developed into an elephant, and his theory then will merit a hearing. We cite beyond other views from Professor Agassiz which bear upon this subject.

firmest conclusions on the ground that the contrary *may* still be right, is hopelessly impregnable to truth. The two modifications of skepticism above alluded to, the speculative and the matter-of-fact, have each their remedy, in a principle which will prove effectual if received and appreciated: the *first*, in the truth that nature is the only source of knowledge about nature,—whence to attempt to lead off, instead of follow, is presumptuous:—the *second*, that the universe, however complex to common view, is, as above observed, an expression of unity of law, both in plan and history, and that a grand purpose of facts is to illustrate this unity. These two principles are united in Prof. Agassiz, and in connection with his habit of exact and untiring research, make him what he is in science.

The first volume of the Natural History of the United States is devoted mainly to *classification* taken in its most comprehensive sense, including whatever illustrates those relations of species upon which classification depends, as well as the nature of classification itself.

The author declares, in the outset, his views of the world of existences, which science aims to comprehend. With much earnestness, he discourses upon nature as a divine system; on thought as no property of matter, and God as not nature. He pronounces the study of natural science the study of the thoughts or ideas which the Creator has embodied in his works, and a true classification of objects in nature as an exhibition of the plan ordained by Him in his omniscience and wisdom. On page 10 we read:—

"I disclaim every intention of introducing in this work any evidence irrelevant to my subject, or of supporting any conclusions not immediately flowing from it; but I cannot overlook nor disregard here the close connection there is between the facts ascertained by scientific investigations, and the discussions now carried on respecting the origin of organized beings. And though I know those, who hold it to be very unscientific to believe that thinking is not something inherent in matter, and that there is an essential difference between inorganic and living and thinking beings, I shall not be prevented by any such pretensions of a false philosophy from expressing my conviction, that, as long as it cannot be shown that matter or physical forces do actually reason, the manifestation of thought is evidence of the existence of a thinking being as the author of such thought, and I shall look upon an intelligent and intelligible connection between the facts of nature as direct proof of the existence of a thinking God, as certainly as man exhibits the power of thinking when he recognizes their natural relations."

Through the discussions which follow, the question of creation by means of physical forces or agencies is considered. On page 13 he says:—

"It is the object of the following paragraphs to show that there are neither agents nor laws in nature known to physicists under the influence, and by the action, of which, these beings could have originated; that, on the contrary, the very nature of these beings and their relations to one another and to the world in which they live, exhibit thought, and can therefore be referred only to the immediate action of a thinking being, even though the manner in which they were called into existence remains for the present a mystery."

The arguments bearing on this topic, which are numerous and variously illustrated, are recapitulated in brief on pages 132 to 135.

"In recapitulating the preceding statements, we may present the following conclusions:—

"1. The connection of all these known features of nature into one system exhibits thought, the most comprehensive thought, in limits transcending the highest wonted powers of man.

"2. The simultaneous existence of the most diversified types under identical circumstances exhibits thought, the ability to adapt a great variety of structures to the most uniform conditions.

"3. The repetition of similar types, under the most diversified circumstances, shows an immaterial connection between them; it exhibits thought, proving directly how completely the Creative Mind is independent of the influence of a material world.

"4. The unity of plan in otherwise highly diversified types of animals, exhibits thought; it exhibits more immediately premeditation, for no plan could embrace such a diversity of beings, called into existence at such long intervals of time, unless it had been framed in the beginning with immediate reference to the end.

"5. The correspondence, now generally known as special homologies, in the details of structure in animals otherwise entirely disconnected, down to the most minute peculiarities, exhibits thought, and more immediately the power of expressing a general proposition in an indefinite number of ways, equally complete in themselves, though differing in all their details.

"6. The various degrees and different kinds of relationship among animals which can have no genealogical connection, exhibit thought, the power of combining different categories into a permanent, harmonious whole, even though the material basis of this harmony be ever changing.

"7. The simultaneous existence, in the earliest geological periods in which animals existed at all, of representatives of all the great types of the animal kingdom, exhibits most especially thought, considerate thought, combining power, premeditation, prescience, omniscience.

"8. The gradation based upon complications of structure which may be traced among animals built upon the same plan, exhibits thought, and especially the power of distributing harmoniously unequal gifts.

"9. The distribution of some types over the most extensive range of the surface of the globe, while others are limited to particular geographical areas, and the various combinations of these types into zoölogical provinces of unequal extent, exhibit thought, a close control in the distribution of the earth's surface among its inhabitants.

"10. The identity of structure of these types, notwithstanding their wide geographical distribution, exhibits thought, that deep thought which, the more it is scrutinized, seems the less capable of being exhausted, though its meaning at the surface appears at once plain and intelligible to every one.

"11. The community of structure in certain respects of animals otherwise entirely different, but living within the same geographical area, exhibits thought, and more particularly the power of adapting most diversified types with peculiar structures to either identical or to different conditions of existence.

"12. The connection, by series, of special structures observed in animals widely scattered over the surface of the globe, exhibits thought, unlimited comprehension, and more directly omnipresence of mind, and also prescience, as far as such series extend through a succession of geological ages.

"13. The relation there is between the size of animals and their structure and form, exhibits thought: it shows that in nature the quantitative differences are as fixedly determined as the qualitative ones.

"14. The independence in the size of animals of the mediums in which they live, exhibits thought, in establishing such close connection between elements so influential in themselves and organized beings so little affected by the nature of these elements.

"15. The permanence of specific peculiarities under every variety of external influences, during each geological period, and under the present state of things upon earth, exhibits thought: it shows, also, that limitation in time is an essential element of all finite beings, while eternity is an attribute of the Deity only.

"16. The definite relations in which animals stand to the surrounding world, exhibit thought; for all animals living together stand respectively, on account of their very differences, in different relations to identical conditions of existence, in a manner which implies a considerate adaptation of their varied organization to these uniform conditions.

"17. The relations in which individuals of the same species stand to one another, exhibit thought, and go far to prove the existence in all living beings of an immaterial, imperishable principle, similar to that which is generally conceded to man only.

"18. The limitation of the range of changes which animals undergo during their growth, exhibits thought; it shows most strikingly the independence of these changes of external influences, and the necessity that they should be determined by a power superior to those influences.

"19. The unequal limitation in the average duration of the life of individuals in different species of animals, exhibits thought; for, however uniform or however diversified the conditions of existence may be under which animals live together, the average duration of life, in different species, is unequally limited. It points, therefore, at a knowledge of time and space, and of the value of time, since the phases of life of different animals are apportioned according to the part they have to perform upon the stage of the world.

"20. The return to a definite norm of animals which multiply in various ways, exhibits thought. It shows how wide a cycle of modulations

may be included in the same conception, without yet departing from a norm expressed more directly in other combinations.

"21. The order of succession of the different types of animals and plants characteristic of the different geological epochs, exhibits thought. It shows, that while the material world is identical in itself in all ages, ever different types of organized beings are called into existence in successive periods.

"22. The localization of some types of animals upon the same points of the surface of the globe, during several successive geological periods, exhibits thought, consecutive thought: the operations of a mind acting in conformity with a plan laid out beforehand and sustained for a long period.

"23. The limitation of closely allied species to different geological periods, exhibits thought; it exhibits the power of sustaining nice distinctions, notwithstanding the interposition of great disturbances by physical revolutions.

"24. The parallelism between the order of succession of animals and plants in geological times, and the gradation among their living representatives, exhibit thought; consecutive thought, superintending the whole development of nature from beginning to end, and disclosing throughout a gradual progress, ending with the introduction of man at the head of the animal creation.

"25. The parallelism between the order of succession of animals in geological times and the changes their living representatives undergo during their embryological growth, exhibits thought; the repetition of the same train of thoughts in the phases of growth of living animals and the successive appearance of their representatives in past ages.

"26. The combination, in many extinct types, of characters which, in later ages, appear disconnected in different types, exhibits thought, prophetic thought, foresight; combinations of thought preceding their manifestation in living forms.

"27. The parallelism between the gradation among animals and the changes they undergo during their growth, exhibits thought, as it discloses everywhere the most intimate connection between essential features of animals which have no necessary physical relation, and can, therefore, not be understood otherwise than as established by a thinking being.

"28. The relations existing between these different series and the geographical distribution of animals, exhibit thought; they show the omnipresence of the Creator.

"29. The mutual dependence of the animal and vegetable kingdoms for their maintenance, exhibits thought; it displays the care with which all conditions of existence, necessary to the maintenance of organized beings, have been balanced.

"30. The dependence of some animals upon others or upon plants for their existence, exhibits thought; it shows to what degree the most complicated combinations of structure and adaptation can be rendered independent of the physical conditions which surround them.

"We may sum up the results of this discussion, up to this point, in still fewer words:—

"All organized beings exhibit in themselves all those categories of structure and of existence upon which a natural system may be founded, in such a manner that, in tracing it, the human mind is only translating into human language the Divine thoughts expressed in nature in living realities.

"All these beings do not exist in consequence of the continued agency of physical causes, but have made their successive appearance upon earth by the immediate intervention of the Creator. As proof, I may sum up my argument in the following manner:

"The products of what are commonly called physical agents are everywhere the same, (that is, upon the whole surface of the globe,) and have always been the same (that is, during all geological periods); while organized beings are everywhere different and have differed in all ages. Between two such series of phenomena there can be no causal or genetic connection.

"31. The combination in time and space of all these thoughtful conceptions exhibits not only thought, it shows also premeditation, power, wisdom, greatness, prescience, omniscience, providence. In one word, all these facts in their natural connection proclaim aloud the One God, whom man may know, adore, and love; and Natural History must, in good time, become the analysis of the thoughts of the Creator of the Universe, as manifested in the animal and plant [and crystal] kingdoms."

If after all, we hear it said still,—that *perhaps* creations may have been due to physical forces—we would repeat, that the notion comes not through science or true inductive philosophy; in all the search thus far, no authority for such an inference has been found. Electricity and its associates we know, but nothing about life-creating force; the daily progress of science is defining, with increasing clearness, the physical agencies of nature, and at the same time stripping them of their old fabulous virtues. The method of creation of a living species appears now, more than ever before, to be a subject beyond the pale of human research—the limit in which man seemingly comes to the precincts of the Infinite. We may look for knowledge; but until nature opens to us a new avenue, this *perhaps* should be set down among man's presumptuous dreamings.

Another topic introduced in connection with the discussions on classification, is that of the relations of the grand system of life and also individual history in species to geological progress. Although the subject is but briefly and collaterally brought in, it is of too much general interest to be passed by without a mention of the views sustained by the author. We arrange the points with reference to their geological bearing.

Professor Agassiz argues with truth that the oldest fossils represent the beginning of animal life on the globe, so far at least as to give a correct exhibition of the earliest types. For the series has its initial point in the same kinds of species on all the continents, reaching down, on each, to salt-water Articulates,

Molluscs and Radiates, if not also to salt-water Vertebrates (Fishes). The great Branches of the animal kingdom thus begin in the inferior or salt-water species; and any obliterated records below, if such there be, could only extend onward this idea, or modify it by limiting somewhat more the range of types.

The author also observes, that the series, thus begun, reached its end in man, and that it admits of proof on anatomical evidence that man is the last term in the series; that upon the earth, no material progress beyond is possible in the plan upon which the animal kingdom is constructed, except in man's own intellectual and moral development. This conclusion follows in fact from the simple progression of form among Vertebrates from the fish onward;—for there is first the horizontal or prone position of the nervous cord with which the series begins,—then the gradual elevation of the cephalic extremity with the new types introduced, and at last the vertical position in man—a *necessary* limit to the series.

The actuality of the progress of life is touched upon and shown to be illustrated through the whole range of geological history. A descending or ascending series of numbers, part of which series is understood, may be easily followed by the mind towards its limits. Of this nature are the facts in geology. The discovery of a type of form at a lower level in the series of strata than before known occasionally takes place; but in no case has the new fact tended to alter essentially the law of the ascending series.

Seaweeds: Ferns and Coniferæ: Angiosperms and Palms;—such is a brief statement of the series in the plant kingdom.

Entomostraca: Tetradecapoda, Anomoura, Macroura: Lower Brachyura: Higher Brachyura;—is the series in Crustacea.

Fishes: Reptiles: Quadrupeds: Man;—is the series among Vertebrates.

The same general idea is illustrated among all the great groups.

Now and then a fact appears that startles the timid, as if nature were not going to prove true to herself. There has been recently discovered a number of new mammalian fossils in the Oolite of Stonesfield, England. But though of great interest, they were but the following out of a discovery made in the same beds thirty-five years ago; and during the interval, mammalian remains have been traced only into the Trias, the beds of the next earlier period. In all, fourteen species have been found in a layer—once evidently a dirt-bed—which is *only five inches thick, and from an area only* 500 *square yards in extent.* The facts, instead of favoring the idea of discovering related fossils in the Carboniferous, renders its probability almost infinitely small. For if such a bed, five inches thick, affords so large a number, then strata like the Coal Measures, abounding

in dirt-beds, thick and thin, and with numerous great beds of land vegetation also, through a series of strata five to fifteen thousand feet thick, a large part of which strata are not marine, ought to afford fossil mammals without limit. It is easy to work out the proportion: and in doing so, it should be remembered that no beds of rock have been more explored, man's cupidity giving great activity and thoroughness to the investigation. The answer to the simple problem would be, some hundreds if not thousands; and yet, notwithstanding all the chances, and all the labor thus far bestowed, not a specimen has been found.

There being some system of progress, the great question is, What is that system?

Is it a law of uniform progress for the Animal Kingdom as a whole? No:—for each of the four Branches, as Professor Agassiz observes, are wholly independent of each other in their whole system of structure and progress.

Is it a law of uniform progress for each of these Branches? or for each of the Classes they contain, as for the class of fishes, or of birds, or of mammals, etc.? The same argument which is used above for the Branches, holds in fact against any such kind of progress for the Classes, Orders, Families and Genera of the Animal Kingdom. For the groups, of either grade, have usually a degree of independence similar to the Branches—a principle which Agassiz insists upon as *universal* for all natural groups, and which certainly holds as a *general* truth. We should therefore no more look for lineal progression between different Orders in a Class, or different Classes in a Branch, than between different systems in the heavens.

In addition to this, a class has not generally been first introduced through the creation of its very simplest species.

On this point, Professor Agassiz says: "The earliest representatives of these classes do not always seem to be the lowest. Yet through all the intricate relations, there runs an evident tendency towards the production of higher and higher types, until, at last, man crowns the series." And he closes this paragraph with the sentiment which seems to be ever dwelling in his mind: "Who can look upon such series, and not read in them the successive manifestations of a thought expressed at different times, in ever new forms, and yet tending to the same end, onwards to the coming of man, whose advent is already prophesied in the first appearance of the earliest fishes?"

This general truth, that the progress is not always, we should say, not commonly, even for small groups, a lineal one, is often misunderstood, and made the basis for reproaches against any idea of progress. Every growing embryo has its superior and also inferior developments; and something analogous is obviously true in zoological history. Each type has usually been

introduced by creations of species that belong to one of its inferior groups, but yet, when so, these earliest forms were not generally the very lowest; and as the expansion of the type afterward took place through new creations, there were downward steps as well as upward, though the upward were eminently the most marked.

Prof. Agassiz appears at times to insist upon an invariably upward progress; but in the above citation, he recognizes the want of generality in the law. If our announcement of the principle is a modification of his view, it appears to us to be one involved in his own statements. As examples of it, the Trilobites were not the lowest of Crustaceans; nor the old Ganoids, the lowest of fishes; nor the Acrogens of the Coal Period, the lowest of land Cryptogams, Mosses and perhaps other orders coming in much later; so also snakes were of later creation than saurians. Quadrupeds, according to the fossils thus far discovered, first appeared in the Marsupials (implacentals), the lower order of Mammalia, and perhaps also in Insectivores, one of the inferior types of placental mammals. But Edentates, the lower of the placentals, and but a single grade above Marsupials appear to have been introduced after Carnivores and Ungulates, and had their time of fullest expansion in the Post-tertiary period. Further discoveries may modify our knowledge respecting this particular case. But the principle is too generally brought out to view, to be set aside, that, through the successive creations, the expansion was to lower as well as higher forms, while mainly to the higher; in all cases, it brought out a purer development of the type and a fuller exhibition of its various capacities.

The fact of progress is none the less true under such a system. Its actual law is daily receiving new illustrations from geological discoveries and becoming gradually intelligible to us in its various details. A hope, which some seem to have, that new facts will throw despite on all general views, is of shallow growth. None need fear that nature will ever prove her own lawlessness.

The important principles connected with this system of progress, brought out by Prof. Agassiz, are as follows:—

First, "*A parallelism between the geological succession of animals and the embryonic growth of their living representatives.*" The young *Comatula*, Prof. A. observes, has first the form of a *Cystidean;* next that of the *Platycrinoid* of the Carboniferous; next that of the *Pentacrinus* of the Lias and Oolite with their whorls of cirrhi; and finally, there is the free *Comatula*, the highest of the Crinoids. With regard to Asterioids and Echinoids, he observes, p. 114:—

"The investigations of Müller upon the larvæ of all the families of living Asterioids and Echinoids enable us to extend these comparisons to the higher Echinoderms also. The first point which strikes the observer

in the facts ascertained by Müller, is the extraordinary similarity of so many larvæ, of such different orders and different families as the Ophiuroids and Asterioids, the Echinoids proper and the Spatangoids, and even the Holothurioids, all of which end, of course, in reproducing their typical peculiarities. It is next very remarkable, that the more advanced larval state of Echinoids and Spatangoids should continue to show such great similarity, that a young Amphidetus hardly differs from a young Echinus. Finally, not to extend these remarks too far, I would only add, that these young Echinoids (Spatangus as well as Echinus proper) have rather a general resemblance to Cidaris, on account of their large spines, than to Echinus proper. Now, these facts agree exactly with what is known of the successive appearance of Echinoids in past ages; their earliest representatives belong to the genera Diadema and Cidaris, next come true Echinoids, later only Spatangoids. When the embryology of the Clypeastroids is known, it will, no doubt, afford other links to connect a larger number of the members of the series."

The young Ganoid of our lakes and rivers has the prolonged caudal vertebral column of the ancient Ganoid; and all the ancient fishes have cartilaginous internal skeletons instead of bony, being thus like the young of the later osseous fishes. Again, among Reptiles, the tailed Batrachians appear to have preceded the tail-less, as the tad-pole precedes the frog in development at the present day. The crabs in their growth pass through a macroural and anomoural form, starting often from an Entomostracan; and the same is the order of creations in geological history. The earlier quadrupeds, as well as other species, in many cases present peculiarities of structure which are now known as embryonic or only temporary conditions in the growth of existing species; Professor Owen alludes to facts of this kind on page 192 of this volume.

It is seen from the preceding and following remarks, that this law, while true as a great principle, has its limitations.

Second. *A parallelism between the geological succession of animals and relative rank among groups or species.* This law is in fact involved in the preceding, in connection with another principle, first propounded by Prof. Agassiz, that the series of successive forms in embryological development affords a scale for ascertaining the grade of species in any given order. If the progress was on the whole from the lower to the higher, and if the grades are marked off in the stages of embryonic growth, then the geological progress should have a degree of parallelism with the successions in embryo development. Agassiz hence finds criteria for ascertaining the rank of groups or species in classification, both in the stages of embryonic growth, and in the stages or steps in the geological history of life. Relations of form or structure to the earlier steps in the former, or the earlier types in the latter, indicate inferiority of grade, and relations to the later, superi-

ority, according to a scale easily apprehended. The worm-like larve, a lower stage of an insect, attests that worms and crustaceans are inferior in grade to insects. And in general, a multiplicity of segments and laxity of parts are proofs of inferiority: as in close accordance, the Trilobites, the earliest of Crustaceans have an excessive multiplication of segments.* But to use the criterion of geological history with success, the principle already stated, that the order of progress is only *in a general way* from the lower to the higher, that is, that the earliest are not always the very lowest, must be borne in mind.

* This principle or general truth in embryology is based upon another of a potential and therefore more fundamental character,—one which the writer has illustrated in his U. S. Expl. Exp. Report on Crustacea (chapter on Classification, p. 1395, and this Journal, xxii, 14). It is this, that cephalic elevation as to quality or grade is concurrent with—and we may say, that in individual growth it is potentially connected with—caudal or posterior abbreviation; and attending it, there is, also, a general compacting of the body and often contraction in size. It is concentration and cephalization, and hence progress. All development from the young upward is in a large degree this kind of cephalic progress,—an elevation in the sensorial organs and the anterior extremity of the body, as well as a compacting of the structure. Thus it is in the insect in passing from the larva to the imago; in the frog and Ganoid fish in passing from the tadpole to the adult; in the crab, in changing from its macroural larve to the perfect animal, and so, generally, through the Animal Kingdom. Comparing groups of species together, the principle comes out in a more comprehensive form. The tape-worm, a worm without a proper head, is indefinite in length; moreover each segment is equal to its neighbor and capable of reproducing by itself the complete animal. But in worms of higher grade, having a head, there is a limit to the length, and this power of self-reproduction does not exist. In the Crustacean there is a still smaller number of segments, and concentration of the anterior part into a circumscribed cephalothorax. In the Crab, the highest Crustacean, the effect is carried to its extreme in the Crustacean type, the abdomen having become very small and lost its members in the extreme thoracicocephalization. In the insect, the body is much shorter and every way far smaller than in the Crustacean, and besides, there is a concentration of the anterior part into a distinct head, separate from the thorax. Again, the lizard has fewer segments than the snake. The higher quadruped has more vertebræ coalesced in the sacrum and a more firmly compacted cranium than the inferior quadruped: that is, as in Crustacea, the cephalothorax, viewing its whole length to the caudal extremity, is more compacted and abbreviated as the grade rises.

The principle explained appears to be a general one. But the comparisons between different species or groups afford right conclusions only when made among species in the same typical series; for when a type as a whole is inferior in grade to another, we cannot of course pass from one to the other in drawing such inferences. Moreover each type has its degradations (that is, species representing degraded or depauperate forms); and in this depauperation there is an abbreviation analogous to that arising from the opposite principle, cephalization. While the tape-worm is one of the lowest of species, there are others still inferior which are little better than a single segment of the tape-worm. While, again, the Decapod Crustacean as it rises in grade, has its abdomen shortened till it becomes memberless in the Crabs, so at the lower end of the scale of Decapods (the Schizopodous group), there are shrimp-like species which have a memberless abdomen. The principle is then, that in a given type, a rising of grade is shown in concentration anteriorly, and abbreviation posteriorly; and a degradation in a relaxation or multiplication of parts, with an elongation posteriorly; a still farther enfeebling is manifested in an obsolescence posteriorly, and sometimes so anteriorly, as well as a general debility of organs and system. It is hardly necessary to add that no change of species into others inferior is here implied, but that actual species represent the conditions mentioned.—D.

THIRD. *The frequent synthetic character of the earlier types.* The Ganoid fishes are a familiar illustration, being often called Sauroid fishes, as they include certain reptilian characteristics in their structure. They are *synthetic* types. To the Ganoids (and in other cases when a future group is foreshadowed), the term *prophetic* type is applied by Agassiz. In after time, fishes come out purely fishes in the Ctenoids and Cycloids, and this is, in part, the kind of expansion or evolution the Fish type underwent. The arborescent Acrogens of the Coal Period appear also to have been synthetic types, combining certain Coniferous characteristics with those of the Fern type. In this case the two component types, the fundamental one and the collateral, were of the same geological age. The Cycadeæ, which prevailed especially in the Middle Reptilian Age, while properly Coniferous, have features of both the Fern type and that of the Palms, the former of these from ancient time, the latter prophetic of the future. The Trilobites constitute, as appears to us, another synthetic type, being Entomostracan, with some peculiarities also of the Isopods (Tetradecapodan). In the Reptilian Age, the Anomoura—a group made up of degraded Brachyura, in which there are many Macroural characteristics—preceded in general the most of the Macroural types as well as the Brachyura. Thus in the early Faunas and Floras the types covered we may say a wider range in their characters; as time moved on, the same space was occupied with analogous types restricted to narrower and deeper channels, that is with stronger, purer, and a more limited range of characteristics; while others, both of superior and inferior grades (and many of them distinctly foreshadowed), were introduced to fill out the scheme.

In the most comprehensive terms, the law is *The general before the special*, the great principle in embryological development, which, as Professor Agassiz observes, von Baer first studied out and thoroughly elucidated.* It is not presented in geology in a manner to favor the notion of the creation of species from species, but rather as an exhibition of unity of idea between growth in the individual, grade of species in the system of nature, and progress in the geological history of life.

A FOURTH law is that of *the culmination and disappearance of types in past time.* The Trilobites, which begun and ended in the Palæozoic ages; the Ammonite group which commenced in the Palæozoic and ended with the Reptilian age; the Brachiopods and Ganoids which first appeared in the Palæozoic and reach on to the present era, though almost wholly extinct—are familiar examples. This is obviously parallel with the fact in embryological development, that parts may fulfil their end and disappear

* This subject is illustrated in its geological bearings at some length in Carpenter's Comparative Physiology, 4th edition.

before the final adult stage is reached. Professor Agassiz, in his remarks on the succession of types, appears to argue that throughout *classes* and *orders* in the Animal Kingdom there was a rising of grade among the species to the last; that is, among the species now existing as representatives of an order, the higher are of superior rank to those representing that order in any earlier time. But perhaps this point requires a farther survey of the facts. It does not seem to be established that the Carnivora of the present age are superior in grade to those of the Post-tertiary, or the Cephalopods of our own seas to those of the Reptilian Age.

After considering many of the laws of relation among animals and between the animal and plant kingdoms, Professor Agassiz introduces an illustration of still wider unity embracing the physical world at large, first suggested by his associate at Cambridge, Professor Peirce. As the facts have not been published in this Journal, we cite a few paragraphs from the chapter. It is well known that the leaves of plants are arranged in spirals, and that the intervals between two successive leaves in the spirals for different plants, varies between $\frac{1}{2}$ and $\frac{1}{3}\frac{3}{4}$ of the circumference; the actually occurring numbers afford the mathematical series $\frac{1}{2}$, $\frac{1}{3}$, $\frac{2}{5}$, $\frac{3}{8}$, $\frac{5}{13}$, $\frac{8}{21}$, $\frac{13}{34}$, $\frac{21}{55}$, etc.; in which the numerator and denominator of each term equals severally the sum of the numerators, and of the denominators, of the two terms next preceding.

"Now, upon comparing this arrangement of the leaves in plants with the revolutions of the members of our solar system, Peirce has discovered the most perfect identity between the fundamental laws which regulate both, as may be at once seen by the following diagram, in which the first column gives the names of the planets, the second column indicates the actual time of revolution of the successive planets, expressed in days, the third column the successive times of revolution of the planets, which are derived from the hypothesis that each time of revolution should have a ratio to those upon each side of it, which shall be one of the ratios of the law of phyllotaxis; and the fourth column, finally, gives the normal series of fractions expressing the law of phyllotaxis.

Neptune,	60,129	62,000	
Uranus,	30,687	31,000	$\frac{1}{2}$
Saturn,	10.759	10,333	$\frac{1}{3}$
Jupiter,	4,333	4,133	$\frac{2}{5}$
Asteroids,	1,200 to 2,000	1,550	$\frac{3}{8}$
Mars,	687	596	$\frac{5}{13}$
Earth,	365	366	$\frac{8}{21}$
Venus,	225	227	$\frac{13}{34}$
Mercury,	88	87	

"In this series the Earth forms a break; but this apparent irregularity admits of an easy explanation. The fractions $\frac{1}{2}$, $\frac{1}{3}$, $\frac{2}{5}$, $\frac{3}{8}$, $\frac{5}{13}$, $\frac{8}{21}$, $\frac{13}{34}$, etc., as expressing the position of successive leaves upon an axis, by the short

way of ascent along the spiral, are identical, as far as their meaning is concerned, with the fractions expressing these same positions, by the long way, namely, $\frac{1}{2}$, $\frac{2}{3}$, $\frac{3}{5}$, $\frac{5}{8}$, $\frac{8}{13}$, $\frac{13}{21}$, $\frac{21}{34}$, etc.

"Let us, therefore, repeat our diagram in another form, the third column giving the theoretical time of revolution.

Neptune,	$\frac{1}{1}$	62,000	60,129
"	$\frac{1}{1}$	62,000	——
Uranus,	$\frac{1}{2}$	31,000	30,687
"	$\frac{1}{2}$	15,500	——
Saturn,	$\frac{2}{3}$	10,333	10,759
"	$\frac{2}{3}$	6,889	——
Jupiter,	$\frac{2}{5}$	4,133	4,333
"	$\frac{3}{5}$	2,480	——
Asteroids,	$\frac{5}{8}$	1,550	1,200
"	$\frac{5}{8}$	968	——
Mars,	$\frac{8}{13}$	596	687
Earth,	$\frac{8}{13}$	366	365
Venus,	$\frac{13}{21}$	227	225
"	$\frac{13}{21}$	140	——
Mercury,	$\frac{21}{34}$	87	88

"It appears from this table, that two intervals usually elapse between two successive planets, so that the normal order of actual fractions is $\frac{1}{2}$, $\frac{1}{3}$, $\frac{2}{5}$, $\frac{3}{8}$, $\frac{5}{13}$, etc., or the fractions by the short way in phyllotaxis, from which, however, the Earth is excluded, while it forms a member of the series by the long way. The explanation of this, suggested by Peirce, is that although the tendency to set off a planet is not sufficient at the end of a single interval, it becomes so strong near the end of the second interval, that the planet is found exterior to the limit of this second interval. Thus, Uranus is rather too far from the Sun relatively to Neptune, Saturn relatively to Uranus, and Jupiter relatively to Saturn, and the planets thus formed engross too large a proportionate share of material, and this is especially the case with Jupiter. Hence, when we come to the Asteroids, the disposition is so strong at the end of a single interval, that the outer Asteroid is but just within this interval, and the whole material of the Asteroids is dispersed in separate masses over a wide space, instead of being concentrated into a single planet. A consequence of this dispersion of the forming agents is, that a small proportionate material is absorbed into the Asteroids. Hence, Mars is ready for formation so far exterior to its true place, that when the next interval elapses the residual force becomes strong enough to form the Earth, after which the normal law is resumed without any further disturbance. Under this law, there can be no planet exterior to Neptune, but there may be one interior to Mercury."—pp. 128, 129.

The subjects to which we have thus far alluded in our notice of Professor Agassiz's work are, as before said, incidental to the author's main purpose, the illustration of the relations of species with reference to principles of classification and the fundamental ideas of system in nature. To this topic we now turn.

(To be continued.)

ART. XX.—*Contributions to the History of Ophiolites.* Part I; by T. STERRY HUNT, of the Geological Survey of Canada.

IN the published reports of the Geological Survey of Canada, Sir W. E. Logan has already shown that the serpentines of the Green Mountains occur in the form of beds, and that they occupy a constant position in the series of altered Lower Silurian strata which make up the principal part of the Green Mountain chain. These metamorphic strata consist of feldspathic, micaceous, epidotic, chloritic, talcose and argillaceous schists, with quartzites, limestones, dolomites and magnesites; besides varieties of euphotide and diorite, pyroxenite and diallage rocks, and others consisting essentially of a white lime-alumina garnet. Intercalated in this series occur the different varieties of serpentine rocks about to be described.

Up to the present time, geologists, with few exceptions, have looked upon serpentine as a rock of igneous origin; but this view is clearly inadmissible for the serpentines of the palæozoic rocks of Canada—whose magnesian strata are, as I have endeavored to show, the result of the alteration of beds of silicious dolomite and magnesite, which have been transformed into silicates under the influence of solutions of alkaline carbonates, a process which requires no very elevated temperature, and enables us to explain the production of those silicates of lime, magnesia and iron which play such an important part in the mineral history of the crystalline stratified rocks.*

Reserving for another occasion the discussion of their mode of formation, I propose at the present time to describe and give the results of my examinations of some of the so-called serpentine-rocks of the Green Mountains. The following pages are copied from the recently published Report of Progress of the Geological Survey of Canada, for the years 1853–1857, pp. 432–443. The same volume contains the results of the chemical and mineralogical examinations of various diallages, diorites, garnet-rocks, talcs, chlorites, dolomites, magnesites, etc., from the formation just noticed. In addition to these, will be found the description of an analogous series of rocks from the Laurentian system, where the serpentines, dolomites, euphotides, diorites, etc., are repeated with certain differences, offering an instructive parallelism with the corresponding Silurian series, and showing that the chemical conditions during the deposition of the oldest known sedimentary rocks were similar to those which prevailed during a portion of the Lower Silurian period, and

* See this Journal (2), vol. xxiii, p. 437, Proceedings of the Royal Society for May 7, 1857, and the Report of the Geological Survey, cited below, p. 477.

have since been repeated many times in the world's geological history. The materials of this report may furnish the subject of farther communications.

The mineral species serpentine is a hydrated silicate of magnesia, whose composition according to the received formula is represented by silica 43·7, magnesia 43·3, water 13·0 = 100·0; a portion of protoxyd of iron, sometimes amounting to ten per cent, generally replaces an equivalent quantity of magnesia.

The rocks known as serpentines are however variable in their constitution, being sometimes composed almost entirely of the silicate just mentioned; at other times this is mingled with other silicates, such as garnet, diallage or hornblende, with quartz, or with carbonate of lime, dolomite or carbonate of magnesia. Mineralogists have therefore distinguished these rocks by the general names of *ophiolite* and *ophicalce*. Thus we have, besides a rock which is composed essentially of serpentine, and may be regarded as the *common* or *normal ophiolite*, varieties characterized by admixtures of garnet, diallage, hornblende and chromic iron ore, which may be respectively designated as *grenatic* or *garnetiferous*, *diallagic*, *hornblendic* and *chromiferous ophiolites;* to these we must add the *quartzose ophiolite* of Brongniart, which is composed of nodules of quartz in a base of serpentine. The *gabbro* of the Italian geologists is a diallagic ophiolite.

The name of *ophicalce* has been given by Brongniart to rocks composed essentially of carbonate of lime and serpentine or talc. Crystalline limestones which hold disseminated grains of serpentine, are designated by him as *granular ophicalce*, while under the name of *reticulated ophicalce* he has described an aggregate of rounded masses of carbonate of lime, cemented by a base of talcose serpentine. In addition to these, the same author describes an aggregate of rounded masses of quartz, green jasper and silicious slate, cemented by serpentine, and several breccias, consisting of angular fragments of quartz, of serpentine, and of jasper, in a paste of serpentine. These rocks he separates from the preceding species under the name of *anagenites* and *breccias*. But such aggregates, in which serpentine is sometimes the paste, and sometimes the imbedded mineral, cannot be separated from certain varieties of ophicalce. Again, in this last species, the calcareous matter is often replaced by dolomite, and even by crystalline carbonate of magnesia, forming varieties of rock to which the name of ophicalce is no longer appropriate. I therefore propose to unite all these varieties under the general name of ophiolite, and to describe them as *calcareous*, *dolomitic* and *magnesitic ophiolites*, which may be granular, gneissoid, conglomerate, or brecciated in their structure. I have been thus particular in distinguishing these different varieties, because they have doubtless a common origin, and because their study will

aid us in getting an idea of the mode of formation of serpentine rocks.

The ophiolites of the Green Mountains often contain diallage, and more rarely actinolite and garnet. Calcareous, dolomitic and magnesitic varieties are common, and are granular, gneissoid, and sometimes conglomerate in their structure. Small portions of nickel and chrome are seldom or never wanting in these rocks, which often contain grains and even beds of chromic iron. Foliated and fibrous varieties of serpentine are also met with there, constituting the varieties which have been named *baltimorite*, *picrolite* and *chrysotile*. A fine collection of ophiolites from the township of Orford, where these rocks are very extensively displayed, has furnished me with a large number of the specimens about to be described.

The analysis of the serpentines was generally effected by treating the mineral in fine powder with sulphuric acid diluted with its own volume of water, and heating the mixture in a platinum capsule until acid fumes were evolved; it was sometimes necessary to repeat this process with the undissolved residue.

The purity of the separated silica was in all cases determined by dissolving it with the aid of heat, in a solution of carbonate of soda. The action of a boiling solution of nitrate of ammonia upon the mineral, either before or after ignition, was generally had recourse to for the determination of any earthy carbonates which might be present.

1. *Normal Ophiolite.*—A very beautiful and homogeneous variety of serpentine rock from the tenth lot of the eighteenth range of Orford, was found to have a density of 2·597. It was finely granular in texture, and had a scaly conchoidal fracture; color deep olive-green, with small bluish veins; it was sub-translucent, and had a highly argillaceous odor. This serpentine holds in very small quantity, disseminated grains of magnetic and chromic iron ores, and contains a little nickel, but no cobalt. When ignited and boiled with a solution of nitrate of ammonia, it gave a trace of magnesia, but no lime. Its analysis yielded:—

Silica,	40·30
Magnesia (by difference),	39·07
Protoxyd of iron,	7·02
Oxyd of nickel,	·26
" " chrome,	(traces.)
Water, by ignition,	13·35
	100·00

2. A fragment of pure serpentine from a conglomerate dolomitic ophiolite about to be described, had a density of 2·622, a blackish-green color, a conchoidal fracture, and was almost opaque. The pulverized and ignited mineral yielded to nitrate of ammonia, 0·40 of carbonate of lime and 0·27 of carbonate of

magnesia. This serpentine contains a small quantity of chromic iron. The oxyd of nickel, determined upon four grams of the mineral, gave no trace of cobalt before the blowpipe. Its analysis gave as follows:—

Silica,	42·90
Magnesia,	36·28
Protoxyd of iron,	7·47
Oxyd of nickel,	·15
Chromic iron,	·25
Loss by ignition,	13·14
	100·19

3. I may cite in this place the analysis of a serpentine given in my Report for 1852, p. 99. It forms the rock in contact with the bed of chromic iron ore in Ham, has a hardness of 3·5, and a density of 2·546. It is massive and compact, with a splintery fracture; color greenish-white, and translucent. The analysis, which failed to detect either chrome or lime, gave as follows:—

Silica,	43·4
Magnesia (by difference),	40·0
Alumina and oxyd of iron,	3·6
Water,	13·0
	100·0

The associated chromic iron ore gave by analysis 0·22 per cent of oxyd of nickel, which, fused with borax before the blowpipe, afforded distinct evidence of the presence of cobalt.

4. A characteristic fibrous serpentine (*picrolite*) from the seventh lot of the eighth range of Bolton, has a hardness of 4, and a density of 2·607. It breaks into ligneous masses several inches in length; very compact; fracture splintery; fibres stiff and elastic; shows an oblique cleavage. Color celandine-green; lustre vitreous, silky; transparent in small fragments; tough, and difficult to pulverize. The finely-sifted powder is completely decomposed by sulphuric acid, and the silica retains the form and lustre of the fibres; the mineral contains apparently as much nickel as 1. Its analysis gave:—

Silica,	43·70
Magnesia,	40·68
Protoxyd of iron,	3·51
Oxyd of nickel (undetermined),	
Water,	12·45
	100·34

5. *Calcareous Ophiolite.*—The specimen of this variety which I have analyzed is from the tenth lot of the sixteenth range of Orford. It is fine grained and sub-crystalline, with a scaly, somewhat conchoidal fracture. Color, mottled greenish-grey,

with an occasional purplish tinge. Translucent on the edges, and resembles, except in color, many common limestones. In powder, the rock effervesces with acetic acid, even in the cold, and by the aid of heat fifty-seven per cent of the mass were dissolved, consisting of carbonate of lime with a little magnesia and a trace of iron. The residue effervesced in the cold with dilute nitric acid, whose action, aided by a gentle heat during half-an-hour, dissolved 10·76 per cent of carbonate of lime and magnesia, with a little iron, corresponding to a ferriferous dolomite. The pale-green residue from the action of the nitric acid, when dried at 212° F., equalled 32·00 per cent. It was readily decomposed by sulphuric acid, without any effervescence, and had the characters of serpentine. Its analysis gave:—

Silica,	41·20
Magnesia,	32·16
Protoxyd of iron,	11·16
Lime,	·65
Alumina,	2·67
Water,	12·70
	100·54

The portion soluble in acetic acid (I.) and that dissolved in nitric acid (II.) had the following composition for 100 parts:—

	I.	II.
Carbonate of lime,	91·33	49·45
" " magnesia,	8·67	43·68
" " iron,	(traces)	6·87
	100·00	100·00

It will be seen that the dilute acids attack but slightly the serpentine, and that the nitric acid dissolves an intermingled dolomite, which is but little acted upon by the acetic acid. I have taken advantage of this reaction to separate the dolomite from the carbonate of lime in a crystalline magnesian limestone, whose analysis is given in my Report for 1854. The proximate analysis of the rock in question shows it to be a mixture of carbonate of lime, dolomite and serpentine, and we have for 100 parts:—

Soluble in acetic acid,	57·00
" " nitric acid,	10·76
Insoluble, serpentine,	32·00
	99·76

6. *Dolomitic Ophiolite.*—This granular variety is from the shore of Brompton Lake, in the seventh range of the thirteenth lot of Orford. It is fine grained and greyish-green like the last, but somewhat darker in color, and weathers reddish-brown. Its fracture is uneven and sub-conchoidal, presenting grains of a

crystalline spar. A fibrous coating is sometimes apparent in the joints of the rock. Its hardness is about 4. When reduced to powder it did not effervesce with acetic acid like the last, but was readily attacked by dilute nitric acid, which removed carbonates of lime, magnesia and iron, with effervescence, leaving a residue of serpentine. A proximate analysis gave 51·9 parts of serpentine, and 48·1 of dolomite = 100·0. The nitric solution contained some manganese and nickel.

The composition of the serpentine left by the nitric acid was:—

Silica,	43·20
Magnesia (by difference),	36·11
Protoxyd of iron with nickel,	8·29
Water,	12·40
	100·00

The dolomite dissolved, gave for 100 parts:—

Carbonate of lime,	49·58
" " magnesia,	46·32
" " iron with manganese,	4·10
	100·00

7. *Dolomitic Ophiolite.*—This rock, also from Brompton Lake, on the twelfth lot of the eighteenth range of Orford, has furnished some fine blocks for ornamental purposes. It is a conglomerate, made up of fragments of serpentine thickly disseminated in a greenish-white dolomitic base. The masses of serpentine vary from a line to more than an inch in diameter, and although rounded, are more or less angular in form. Their colors are various shades of dark green, sometimes appearing nearly black when polished. The analysis of one of these imbedded masses has already been given (No. 2). This rock contains both nickel and chromic iron.

An average specimen of the conglomerate was pulverized for examination. The powder effervesced even in the cold, with acetic acid, which with the aid of heat, took up by prolonged digestion, twenty per cent of carbonates of lime and magnesia, and 0·2 of oxyd of iron. The soluble portion contained carbonate of lime 88·30, carbonate of magnesia 11·70. The residue from acetic acid effervesced slightly with warm dilute nitric acid, and the solution was found to contain a quantity of magnesia equivalent to 5·68 per cent of the original mass (11·70 per cent of magnesian carbonate), besides 1·36 of peroxyd of iron and 0·60 of alumina, but no lime, the whole of that base having been removed by the acetic acid. The residue from the action of nitric acid, was decomposed by fusion with carbonate of soda, and gave:—

Silica,	45·10
Magnesia, (by difference),	34·68
Protoxyd of iron,	6·12
Alumina,	·80
Water,	13·30
	100·00

This residue when ignited, yielded but a trace of magnesia to a boiling solution of nitrate of ammonia, showing that it retained no carbonate; but from the excess of silica it was evident that a partial decomposition of the serpentine had been effected by the nitric acid. In confirmation of this, I found that a second portion of the pulverized rock, when submitted to a prolonged digestion with acetic acid, left 75·5 per cent of matter dried at 212° F.; this residue gave a feeble effervescence with nitric acid, which by prolonged digestion, took up 13·0 per cent of magnesia, although when previously ignited, the residue gave to a solution of nitrate of ammonia only a trace of lime, and but 0·3 per cent of magnesia. Its analysis by fusion with carbonate of soda gave:—

Silica,	43·10
Magnesia,	35·52
Protoxyd of iron,	8·82
Water,	11·90
	99·34

Another specimen of the conglomerate was now pulverized, and eight grams of it were digested for a long time with boiling acetic acid; the insoluble residue, after levigation, was subjected a second time to the same treatment. The matters thus dissolved for 100 parts of the mineral, were:—

Carbonate of lime,	7·35
" " magnesia,	7·72
" " iron,	1·78
	16·85

A portion of the residue from the acid was ignited and boiled with nitrate of ammonia, which dissolved a portion of lime equal to 0·3 per cent of carbonate, and of magnesia equal to 3·26 of carbonate of magnesia; making a total of 10·98 of carbonate of magnesia to 7·65 of carbonate of lime. The serpentine residue, still containing these 3·56 per cent of carbonates, gave by analysis with carbonate of soda, the following results:—

Silica, (by difference),	43·93
Magnesia,	35·64
Protoxyd of iron,	7·83
Lime,	(traces.)
Loss by ignition,	12·60
	100·00

A portion of the powder of this last specimen of the conglomerate was ignited for ten minutes over a spirit-lamp, and then boiled with a solution of nitrate of ammonia, so long as a perceptible odor of ammonia was evolved; there were dissolved by this means 6·50 per cent of carbonate of lime, and 7·65 of carbonate of magnesia.

Veins of from four to six lines in breadth are often met with in this conglomerate. Their walls are covered with a thin layer of pale green serpentine, having a fibrous structure perpendicular to the sides of the vein; upon this is deposited a bluish-white fine grained dolomite, while in the middle a nearly pure cleavable calcite occurs. The analysis of a portion of this dolomite gave:—

Carbonate of lime,	59·32
" " magnesia,	34·15
" " iron,	4·83
	98·30

8. *Magnesitic Ophiolite.*—In the three preceding specimens we have examples of ophiolites which are mixtures of serpentine with carbonates of lime and magnesia; in the first the lime is greatly in excess, in the second the two carbonates are united in the proportions required to form a dolomite, while in the third the magnesian carbonate predominates, but from the action of cold acetic acid, it would appear that a portion at least of the carbonate of lime in this specimen, is not in chemical combination with the magnesian carbonate. The history of these rocks would however be incomplete without the description of another variety, in which the carbonate of lime is entirely wanting, and which consists wholly of silicates and carbonates of magnesia and iron. This remarkable rock has not yet been noticed in Canada, but is found in Vermont, in the southern prolongation of the Green Mountains, and constitutes the so-called serpentine marble of Roxbury in that state; it has been examined by Dr. C. T. Jackson and Dr. A. A. Hayes of Boston.

Dr. Jackson (this Journal, [2], vol. xxiii, p. 125,) succeeded in separating from the rock a mineral having the composition of serpentine, and describes veins composed of ferriferous carbonate of magnesia, and others of ferriferous dolomite, which traverse the mass. According to Dr. Hayes, (ibid, [2], vol. xxi, p. 382,) the rock is an aggregate of fibrous and compact asbestus, talc, chlorite and chromic iron, with angular fragments of talc-schist and argillite, the whole cemented by carbonate of magnesia, which forms according to him, on an average, 38 p. c. of the mass. He has also shown that the ophiolites of Cavendish, and of Lynnfield in the same region, contain carbonate of magnesia, without any lime. Through the kindness of the above-named

gentlemen, I have been furnished with a series of specimens, which have permitted me to make a careful examination of the Roxbury ophiolite.

Some portions of the rock appear as a mottled granular mass, having a hardness of about 4·0, with an uneven fracture, and presenting cleavable grains of magnesite; the colors vary from blackish-green to greenish-white, and the rock is susceptible of a high polish. Other specimens are white and crystalline, with numerous greenish-grey bands, the whole arranged in parallel layers, as if stratified, and resembling closely some varieties of gneiss. The rock cleaves with these layers, which contain serpentine and talc, intermingled with carbonate of magnesia. This mineral, as described by Drs. Jackson and Hayes, is nearly pure in the white portions, and has a hardness of 4·0, and a density of 2·99—3·00, according to my determinations. Dr. Hayes found for its composition, carbonic acid 48·80, magnesia 45·60, talc and a little silica 3·60, silicate of protoxyd of iron 1·96 = 99·96.

This result corresponds closely with my own. I obtained from 100 parts, 2·76 of talc, and 1·82 of silica, besides 2·40 of peroxyd of iron, corresponding to 3·48 of carbonate of iron, the rest being carbonic acid and magnesia, with a little manganese. The greater portion of the iron exists here as carbonate, as is evident from the fact that it is dissolved by a boiling solution of nitrate of ammonia; but there is also present a portion of silicate of iron and magnesia, decomposed by acids. In my analysis the powdered magnesite was digested for a long time at a boiling heat with hydrochloric acid; the insoluble portion was then boiled with strong sulphuric acid, and from the residue the silica was removed by a solution of carbonate of soda, the talc remaining.

The talc thus purified from magnesite and serpentine by successive treatments with hydrochloric and sulphuric acids and carbonate of soda, was gently ignited, and then decomposed by fusion with carbonate of soda; it gave:—

Silica,	62·60
Magnesia,	31·30
Alumina and oxyd of iron,	4·06
Water and loss,	2·04
	100·00

In the analysis of Dr. Hayes just cited, the 48·80 parts of carbonic acid are sufficient only for 44·36 parts of magnesia, leaving 1·24 of this base in the form of a silicate decomposable by sulphuric acid. In order to determine the composition of this silicate, a dark-green portion of the rock was pulverized, and boiled for a long time with dilute nitric acid, which dissolved

a large amount of magnesia with disengagement of carbonic acid; the solution contained besides, magnesia, iron, manganese, and a trace of nickel, but no lime. The undissolved residue was then boiled with a solution of carbonate of soda, which took up a considerable amount of silica derived from the silicate which had been partially decomposed by the nitric acid, and left a dense granular matter, mingled with silvery scales of greenish talc, which were in great part removed by washing. The denser silicate was then dried at 250° F., and submitted to analysis. By ignition it lost 11·40 per cent, and then gave to a boiling solution of nitrate of ammonia a quantity of magnesia equal to 1·21 of carbonate. Another portion was decomposed by sulphuric acid, and the silica separated from the insoluble talc by a solution of carbonate of soda. The results of the analysis were as follows:—

Silica,	39·60
Magnesia,	36·72
Protoxyd of iron,	4·86
Oxyd of nickel,	(traces.)
Talc,	6·80
Water,	10·77
Carbonic acid,	·63
	99·38

Deducting the talc, the carbonic acid, and the amount of magnesia required to form with it 1·21 of carbonate, we have for the composition of this silicate dried at 250° F.:—

Silica,	43·34
Magnesia,	39·55
Protoxyd of iron,	5·32
Oxyd of nickel,	(traces.)
Water,	11·79
	100·00

This is the composition of serpentine, and the ophiolite of Roxbury is thus shown to consist of serpentine and talc, intermixed with a ferriferous carbonate of magnesia; the compact asbestus of Dr. Hayes is nothing more than serpentine.

In the second part of this paper I propose to describe among others, some of the ophiolites of the Laurentian series.

ART. XXI.—*The Chalchihuitl of the ancient Mexicans: its locality and association, and its identity with Turquois;* by W. P. BLAKE.

THE Navajo Indians in the northern and western portion of New Mexico wear small ornaments and trinkets, fashioned out of a hard, green stone which they call *Chalchihuitl.** It is esteemed among them as a gem of very great value, holding a rank equal to that of the diamond with us. It is more highly prized than gold, and is often used in trade among themselves, a string of fragments large enough for an ear-ring being worth as much as a mule. Few or none of these stones are obtained by strangers, for they are never disposed to give for them what the Indians require.

The descriptions of this stone led me to regard it as Turquois, and learning that it was yet procured in small quantity by the Indians from a mountainous district not over twenty miles from Santa Fé, I visited the locality and collected several specimens.

The mountains form a group of conical peaks and are known as *Los Cerrillos.* They are southeast of Santa Fé, and north of the Placer or Gold mountains, from which they are separated by the valley of Galisteo river. The rocks of which they are composed are yellow and gray quartzose sandstones, and porphyry in dykes. The sandstones are probably of the age of the Carboniferous, and are much uplifted and metamorphosed, so that their sedimentary character is in great part obliterated.

On reaching the locality I was struck with astonishment at the extent of the excavation. It is an immense pit with precipitous sides of angular rock, projecting in crags, which sustain a growth of pines and shrubs in the fissures. On one side the rocks tower into a precipice and overhang so as to form a cave; at another place the side is low and formed of the broken rocks which were removed. From the top of the cliff, the excavation appears to be 200 feet in depth and 300 or more in width. The bottom is funnel-shaped and formed by the sloping banks of the debris or fragments of the sides. On this debris, at the bottom of the pit, pine trees over a hundred years old are now growing, and the bank of refuse rock is similarly covered with trees. This great excavation is made in the solid rock, and tens of thousands of tons of rock have been broken out. This is not the only opening; there are several pits in the vicinity, more limited in extent, some of them being apparently much more recent.

Traces of the *Chalchihuitl* were found among the broken rocks, but almost every fragment of large size and good color had

* This name is now pronounced *chal-che-we-te* by the Indians, and *char-che-we-te* by some of the New Mexicans. The Indian pronunciation is preferred.

been carefully collected. A recent heavy shower had, however, brought many small pieces of the mineral in view on the surface, and other specimens were procured by breaking open the rocks.

The specimens present in color various shades of apple-green and pea-green, passing into bluish-green. Some fragments having a blue color were found, but these are not so dense and hard as the green. Some of the specimens very closely resemble crusts or coatings of chrysocolla both in fracture and color; differing, however, very essentially in the hardness. Some of the bluish specimens are very soft and earthy, and appear to be the result of partial decomposition of the green portions by long exposure. One of the compact green fragments has been successfully cut by a lapidary; it takes a fine polish, and has a pleasing color and lustre suitable for jewelry. The hardness is a little less than that of feldspar, and the specific gravity varies from 2·426 to 2·651, the compact, green fragments giving the highest numbers.

Before the blowpipe, it fuses with intumescence on the thin edges only; in other respects, the reactions are similar to those of turquois. An analysis of it for me by J. M. Blake of the Yale Analytical Laboratory shows it to be nearly identical with turquois in composition, being a hydrous phosphate of alumina and iron, colored with oxyd of copper.

The fragments which were picked up do not exceed three quarters of an inch in length and one quarter of an inch in thickness. They appeared to have formed crusts upon the surfaces of fissures or cavities in the rock, or to have extended through it in veins. It was so found in the rock, ramifying in various directions in seams from the thickness of a card to three tenths of an inch or more. It is not accompanied, so far as could be ascertained, by any minerals, except in some cases by peroxyd of iron and a little quartz, the former being apparently the result of the decomposition of pyrites. The seams in the rock are compact and homogeneous, and the mineral adheres closely to the walls on each side. It is therefore difficult to break out fragments of large size. In some places the mineral does not form a continuous seam or crust, but is implanted in irregularly circular spots, or reniform masses along the walls of the fissures. At one of the openings most distant from the ancient excavation, it occurs in small, irregular nodules, in cavernous portions of the rock where there is much peroxyd of iron. It is occasionally seen isolated and completely enveloped in the body of the rock, but near either a fissure or a cavity. In all cases it is compact and without any trace of crystalline structure, breaking with a smooth conchoidal fracture. Several of the specimens are nearly identical in appearance with the turquois from Steine in Silesia, for a fragment of which I am indebted to Prof. G. J. Brush.

On breaking open one of the dark green fragments a small cavity was found in the centre, like the interior of a geode, with the color gradually shading into white. The interior surface is smooth and finely mamillated, reminding one of the inner surface of nodules of chalcedony. There are not any distinct layers as in agate but the color gradually diminishes from the surface to the center. A variation in the amount of the coloring matter in different specimens according to the circumstances of formation is thus indicated, and it is seen that the composition of the mineral cannot be regarded as constant. This variation of color, and the structure, indicate an origin, or formation, similar to that of chalcedony and agate,—a deposition in thin layers from either a vapor or liquid.

There did not appear to be any principal vein or well defined deposit of the mineral; it is apparently distributed in thin seams through a great body of the rock. It is possible that there is a large vein or seam covered from view by the debris. The rock is a granular porphyry, yellowish, gray and white, in color; porous and earthy in texture. It decomposes rapidly by weathering, and very much resembles a sandstone. Veins of copper pyrites associated with gold, and veins of argentiferous lead occur in the same mountains, but there are no indications of ores at the locality. The sides of the pits were carefully examined to determine whether it was possible that the excavation had been in part made for ores or the precious metals, but it was evident that the chalchihuitl was the only mineral which had been sought for.

The evident antiquity of this excavation, and its extent, renders it peculiarly interesting. Little or nothing appears to be known of it in that region, and I am not aware that it has ever been visited except by the Indians and New Mexicans. It seems hardly possible that such an amount of rock could have been removed by men without the aid of powder and machinery. The evidences were, however, conclusive that it was the work of the aborigines long before the conquest and settlement of the country by the Spaniards. It does not appear that anything has been done in the great pit for a long time. This is shown not only by the pine trees growing in it, but by the lichen-covered sides, and by the piles of rock, gray with age, around the margin. Fragments of ancient Indian pottery can easily be found among the rocks at all of the excavations. It is said that the Indians have a tradition that eight or nine of their tribe were once suddenly buried by a fall of rocks from the side of the great pit. Since that time they have been afraid to work in it. This is probable, and it is indicated by the condition of the locality. The place is, however, occasionally visited by Indians from a distance, but their operations appear to be confined to the sur-

rounding openings, or to breaking up masses of rock which were formerly removed. The fragments which they procure are taken to one of the Indian pueblos on the Rio Grande, where the art of grinding and perforating them for beads is yet known. How this is accomplished, I could not ascertain. Two or three Indians, only, go to the locality at one time, and while there they live in the cave or recess in the face of the cliff. At one side of this there was a litter of cedar boughs, and on the other, a great accumulation of ashes, the residue of camp-fires. A more picturesque abode can hardly be imagined. The entrance fronts upon, and overlooks, the ancient excavation, with its crags and forest of pines; the broad sloping plain or plateau of Santa Fé stretches out to the north, with the lofty peaks of the Rocky Mountain chain rising above it. On the west and southwest the country is open towards the Rio Grande, the monotony of the broad plains being relieved by the Sandia or Albuquerque mountains.

On my return from New Mexico I became curious to know whether any mention of the ancient excavation or of the chalchihuitl was made by the early historians or travellers in Mexico. I was much gratified to find that the mineral is mentioned by Bernal Diaz, the companion of Cortes, and others. Bernal Diaz states that, on the landing of Cortes at San Juan de Ulloa, the ambassador from Montezuma brought presents of richly worked mantles and trinkets of gold, in addition, *four chalchihuitls* intended for the Spanish Sovereign. These, the ambassadors said, were each worth more than a load of gold.* Diaz remarks that they were a species of green stone of uncommon value, which were held in higher estimation among the Indians than the smaragdus [emerald] with the Spaniards.

Torquemada makes frequent mention of chalchihuitl and regarded it as a species of emerald. He states that the Mexicans gave the name *Chalchihuitl* to Cortes, intending thus to show their respect for him as a captain of great valor, "for Chalchihuitl is of the color of the emerald, and emeralds were held in great esteem."† Offerings of this stone were made by the Indians in the temple of the goddess Matlalcueye,‡ and it was their custom to place a fragment in the mouths of the distinguished chiefs who died. Torquemada, in recording this fact, says that these stones were emeralds but that they were called chalchihuitls by the Indians.§ When Alvarado and Montezuma played together at games of chance, Alvarado paid, if he lost, in chalchihuitl stones, but received gold if he won.‖ The Indians

* History of the Conquest of Mexico, by Bernal Diaz, Lockhart's translation, vol. i, p. 93.

† Torquemada, Monarchia Indiana, ii, p. 435.

‡ Ibid, p. 288. § Ibid, p. 521. ‖ Ibid, i, p. 462.

stated that the art of cutting and polishing chalchihuitl was taught them by the god Quetzalcohuatl. Sahagun considered the stone to be a jasper of a very green color, or a common smaragdus.* He remarks that they are green and opaque, and are much worn by the chiefs strung on a thread around their wrists, being regarded as a badge of distinction.†

In the year 1539 Friar Marco de Niça made a journey among the Indians of New Mexico, and in his narrative frequently mentions green and bluish stones which were worn as ornaments by them, pendant from the ears and nose. He also mentions seeing many "*turqueses*" which there is little doubt he considered the green stones to be. These turquoises were worn not only in the ears and nose but as necklaces and girdles. They were called *Cacona* by the Indians and were obtained from the kingdom of Cevola. On arriving at this place De Niça observes that "the people have emeralds and other jewels, although they esteem none so much as turqueses wherewith they adorn the walls of the porches of their houses and their apparel and vessels, and they use them instead of money through all the country.‡ Coronado, who visited Cevola in 1540, denies De Niça's statement respecting the turquoises upon the porches of the houses, but he obtained turquois ear-rings and tablets set with the stones.

The emeralds, turquoises, and chalchihuitl of the different authors were doubtless one and the same mineral—the chalchihuitl. There is little reason to suppose that there was more than one locality; that which has been described was probably the source of all the specimens. To supply the great demand for them among all the tribes of New and Old Mexico, must have required a vast amount of quarrying, fully equal to that at the locality.

Names similar to chalchihuitl, or derived from it, were common among the ancient Mexicans and the word is doubtless of Aztec origin. It is differently written by the early historians. Torquemada gives Chalchihuitl as the Indian name but frequently writes it *chalchihuite*. Lockhart, the translator of the narrative by Bernal Diaz, writes *chalchihuitls*, but says that the stones were called *chalchuites* by Diaz. It is singular that De Niça and Coronado do not mention this name; it would appear that it was not in use in the region they visited. The mention of the fact that the stones were called *cacona* by one of the tribes of Indians renders this more probable. As the stone was recog-

* Historia de la Conquista de Mexico.

† Hist. de Nueva España, lib. ii, cap. 8.

‡ See Extracts from the Journal of Friar Marco de Niça, published in the Indian Report by Lieut. A. W. Whippie, Pacific R. R. Explorations and Surveys, vol. iii, p. 106–107.

nized as identical with turquois by these travellers, it is possible that they neglected to give the Mexican name. It is also possible that this name originated in Mexico and not among the tribes near the locality, although it is now in use there. It is desirable that this ancient name should be retained and I suggest that this New Mexican variety of turquois may be appropriately known among mineralogists as *chalchihuitl*.

ART. XXII.—*On a method of Preparing and Mounting Hard Tissues for the Microscope;* by CHRISTOPHER JOHNSTON, M.D.

HAVING for several years occupied my leisure moments with what are usually denominated "microscopical studies," I beg leave to offer, as the result of successful experience, a simple and certain method of preparing and mounting *hard tissues*, such as bone, teeth, shells, fossilized wood, &c.

I am aware that treatises upon the microscope give a few indications for making sections and embalming them in Canada balsam; but they are unsatisfactory either by reason of their brevity or their want of precision. Specimens may be procured ready-made from the hands of Topping, Bourgogne and others, but while they are expensive, persons in remote situations are obliged to purchase by catalogue without the opportunity of selection. Besides, it is oftentimes difficult or else impossible to obtain series of particular objects; so that the student must either limit his researches or "prepare" for himself: in the latter case he may increase his number of objects indefinitely, and supply himself with many such as are not attainable from abroad, and divided in any direction he may require.

A microscopic section should be as thin as the structure of the object will allow, of uniform thickness, and polished on both sides, whether it be mounted in the dry way or in balsam. To meet these requirements I proceed as follows:—

Being provided with

1. A coarse and a fine 'Kansas hone, kept dressed *flat* with fine emery;

2. A long fine Stub's dentist's file;

3. A thin dividing file and fine saw;

4. Some Russian isinglass boiled, strained, and mixed with alcohol sufficient to form a *tolerably* thick jelly when cold;

5. A small quantity of Canada balsam;

6. Slides; 7. Cover glass;

8. One ounce of chloroform; 9. One of F.F. aqua ammonia;

10. Some fragments of thick plate (mirror) glass 1 inch square or 1 by 2 inches; and finally,

11. An ounce of "dentist's silex," and

12. Thin French letter paper, of which 500 or more leaves are required to fill up the space of an inch: I examine the object and decide upon the plane of the proposed section.

Coarse approximative sections may be obtained with the saw or dividing file (excepting silicified substances), but these instruments are not applicable to longitudinal sections of small human or other teeth, small bones, &c. Take now the object in the fingers if sufficiently large, and grind it upon the coarse hone with water, to which add "silex" if necessary, until the surface coincides with the intended plane. Wash carefully: finish upon the finer hone; and polish upon soft linen stretched upon a smooth block.

If the object be too small to admit of immediate manipulation it should be fastened upon a piece of glass with isinglass—or what is better, upon thin paper well glued with the same substance upon glass; and a piece of thick paper or visiting card, perforated with a free aperture for the object, must be attached to the first paper. This is the *guard*, down to which the specimen must be ground with oil: and its thickness and the disposal of the object require the exercise of good judgment. Hot water will release everything; and chloroform remove the grease from the specimen, which, like that ground with water, is ready for the second part of the process.

2d. Carefully cover the surface of a piece of the plate glass with thin French letter paper; next apply a paper *guard*, as before stated, but not thicker, for teeth and bone, than $\frac{1}{100}$th inch; then trace a few lines with a lead pencil upon the first paper in the little space left in the *guard* so that the increasing transparency of a specimen being prepared may be appreciated; and finally moisten the "space" with isinglass to the extent of the object, which must be delicately brushed over on the ground surface and at the *edges* with tolerably thin isinglass before it is cemented in its place. Gentle pressure should now be employed, and maintained with a wire spring, or thread wound round about.

In two or three hours the second side may be ground in oil; silex may be employed at first, or even a file; but these means must not be persevered in, and the operation must be completed upon the bare hone. When the second side shall have been wiped with chloroform it may be polished with a bit of silk upon the finger; and after *spontaneous* separation from the paper in hot water the specimen ought to be well washed on both sides with a camel's hair pencil and soap water, dropped into cold water, and thence extracted to dry. After immersion in chloroform for a moment, and examination for the removal of possibly adherent particles, the *section* may be declared suitable for mounting.

Before proceeding to this step, a few precautions are necessary about particular sections. Transverse sections of teeth or bone should be dried, after the preliminary washing, between glass, in order to avoid the disadvantage of warping. Very porous parts, such as cancellated bone, or fragile bodies, such as the poison fang of serpents, require that the whole structure, or the canals, be saturated with glue and dried. Sections may now be cut with a saw, ground in oil, and cemented to the holding-glass subsequent to immersion in chloroform.

Mounting.—Spread a sufficient quantity of old Canada balsam, or of that thickened by heat (not boiling), upon a slide, and, when cold, impose the section. Have ready a spatula bearing a quantity of equally inspissated balsam warmed until it flows, with which cover the specimen, and then immediately warm the slide, being careful to employ the least possible heat. Now carefully depress the section and withdraw every air bubble with a stout needle set in a handle towards the ends of the slide: put on the cover glass, slightly warmed, not flat, but allowing one edge to touch the balsam first, press out superfluous balsam, and the specimen is safe. The slide may now be cleaned with a warm knife, spirits of wine, and ammonia.

This communication would be incomplete without some very important hints concerning "cover glass." It is easy to clean small covers, but very thin glasses or large ones, one or two inches in length, are not so safely handled. All danger of breaking is, however, avoided by placing a cover upon a large clean slide, and wiping one side only with a bit of linen damp with aqua ammonia, and then with a dry piece. The other side may be cleaned after the mounting.

In the next place, all preparers are aware of the difficulty attending the use and application of large covers. I beg leave to assure the inexpert that the following method will insure success. Having prepared the cover glass and superposed it, let it first be gently pressed downwards at many points with the flat end of a lead pencil: it will be found, however, almost impossible to flatten it without breaking, consequently too much balsam will overlie and underlie the section. Let now a piece of thin paper be laid over the cover and upon this a thick slide; if a moderate heat be applied to both the slides, over and beneath the specimen, direct pressure evenly exerted with the fingers (or spring clothespins) will force out all unnecessary balsam, and leave the section and the protecting cover perfectly flat and unbroken.

The reader will not deem me too prolix when he attempts his first preparation, or when, after having followed the plans so scantily given in the books, he feels the need of something precisely definite. It is certain that neither Canada balsam nor gum mastic will retain the first ground side of a specimen upon

a slide long enough to enable the preparer to reduce it to the requisite thinness, and with both these substances *heat* must be employed, which is objectionable because most objects are thereby warped or cracked; and furthermore the paper *guard*, which I hold to be indispensable for limiting and equalizing the thinness of a section, is not mentioned in treatises, in which, if known to the author, such a measure should be noticed. But it is possible to fasten agate, fossil wood, &c. with hot gum shellac, so that they may be ground upon both sides with a water stone; but even in these instances invidious cracks may endanger or destroy the beauty of a choice preparation.

I am confident that my specimens are second to none in any respect: and the highly creditable performances of friends, to whom I have given the method forming the subject of this communication, lead me to believe that with the facilities it affords the observers of our country will need no Topping for objects within their reach, and I beg leave to add that the profitable pleasure I have enjoyed induces me, through the American Journal of Science, to invite participation.

Baltimore, Nov. 15th, 1857.

ART. XXIII.—*Blodget's Climatology of the United States and of the Temperate Latitudes of the North American Continent.**

THIS work relates to a subject of great practical importance to the people of the United States, and one which hitherto has received but partial attention. In 1842 there was published a volume on "the Climate of the United States and its endemic influences, by Samuel Forry, M.D." This was an octavo volume of 380 pages, more than two-thirds of which were devoted to an application of the laws of climate to the elucidation of disease. The general subject of the climate of the United States was therefore treated in a very brief manner, and the materials for extending the investigation much beyond the Mississippi Valley were very imperfect.

The work of Mr. Blodget contains a summary of the statistics of Meteorological Observations, furnishing the mean temperature of each month at 250 stations scattered all over the United States,

* Climatology of the United States and of the temperate latitudes of the North American Continent, embracing a full comparison of these with the Climatology of the temperate latitudes of Europe and Asia, and especially in regard to Agriculture, Sanitary investigations and Engineering, with Isothermal and Rain Charts for each season, the extreme months and the year, including a Summary of the Statistics of meteorological observations in the United States, condensed from recent scientific and official publications. By LORIN BLODGET. 536 pp. large 8vo, with maps. 1857. Philadelphia, J. B. Lippincott & Co.; London, Trübner & Co.

and at 150 stations for other portions of the northern hemisphere; also the average amount of rain for each month at 200 stations in the United States, and more than 50 stations on the Eastern continent. It contains an outline of the Physical Geography of the United States; it describes the general character of the climate of the Eastern United States; as also that of the interior and of the Pacific coast; it institutes a comparison between the arid and interior areas of the two continents; between the Eastern United States and the West of Europe, and also a comparison between the basin of the Gulf of Mexico and that of the Mediterranean sea. It describes the distribution of heat in the United States, for each month and for the four seasons, and a comprehensive summary of the results is presented in a series of isothermal charts. It describes the distribution of rain, for each of the four seasons, and also for the entire year, and the results are exhibited upon a series of rain charts. It notices the winds and the winter storms, together with the hurricanes of the United States. It discusses the relations of climate to vegetation, particularly to the grand staples of the United States, Indian corn, sugar cane, cotton, wheat, etc. It treats briefly of the dependence of disease upon climate; and discusses the question of the permanence of climate. It is seldom that we find introduced into a single volume such a variety of topics, calculated to interest the great mass of an intelligent community. The author moreover assures us that "*no part of this work is the result of hasty or superficial discussion*, and that all the steps of analytical investigation and detailed criticism required for such a purpose as that of constructing an approximate climatology have been taken in advance." We could not ask for stronger assurance than this, and we address ourselves to an examination of the work in the confident expectation of finding much new light shed upon many subjects which have been hitherto but imperfectly understood.

The distribution of temperature in the United States is shown to be extremely irregular, and the isothermal lines pay very little respect to parallels of latitude. Throughout the whole country east of the Mississippi, these irregularities are less remarkable, and the position of the lines of equal temperature is substantially the same as has been long since assigned them; but between the Mississippi and the Pacific Ocean lies a territory which until recently was almost wholly unexplored. The publication of the Army Meteorological Register in 1855, furnished materials which indicated the most prominent features of the climate of this region. We will mention briefly a few of the most important facts brought to light by the publication of the Army Meteorological Register and the Climatology of Mr. Blodget.

1. In latitude 33°, within 150 miles of the Pacific coast, is a district whose mean temperature during the three months of summer is 90°. This is shown by the observations at Fort Yuma. Fort Yuma is situated on the west bank of the Great Colorado, eighty miles from the Gulf of California in latitude 32° 43′, and longitude 114° 36′. The locality is a rocky bluff, 75 feet above the river, and 120 feet above the sea, with sand hills and rocky bluffs bordering the wide valley, and connecting with an immense sand desert on the west. The following are the results of three years observations.

	Mean temperature of				Mean of 3 summer months.	Maximum temp'ture.
	June.	July.	August.	Sept.		
	°	°	°	°	°	°
1852	87·00	88·65	88·10	83·55	87·92	108
1853	89·49	94·12	92·16	89·33	91·92	121
1854	85·40	94·05	90 62	85·48	90·02	113
Mean	87·29	92·27	90·29	86 12	89 95	

In order to appreciate the importance of this result, we must compare it with observations made in other parts of the world. *From no other station on the American continent do we find observations indicating a mean temperature for summer so high by more than two degrees.* On the Eastern continent a few instances of higher temperature are recorded. Professor Dove has furnished us the mean temperature of nearly 1000 stations scattered all over the globe, and among these the following are the only instances which furnish a mean summer temperature as high as 90°.

	Latitude.	Longitude.	Mean temperature of				3 Summer months.	No. of years.
			June.	July.	August	Sept.		
	° ′	° ′	°	°	°	°	°	
Pondichery,	11 56 N.	79 52 E.	95 40	93·80	92·00	89·50	93 73	1
Bagdad,	33 21 N.	44 22	92·08	93·20	94·10	87·35	93·13	1
Upper Egypt,	26 0 N.	33 40	90 50	94·44	91·06	86·56	92·02	1
Abusheher,	28 15 N.	50 54	89·78	93 74	92·48	88·52	92·01	1
Mosul,	36 19 N.	43 10	87·10	94·10	90·64	80·98	90·61	1

At each of these stations the observations embrace only a period of one year, and it is not improbable that the results would be somewhat reduced by observations continued for a longer period. In conclusion we find that Fort Yuma is the hottest place at present known on the Western continent, and is exceeded by only a very small portion of the Eastern continent.

2. The mean temperature of the coast of California during summer, is about twenty degrees colder than at places 100 miles in the interior upon the same parallel. This will appear from the following comparison.

	On the Coast.		Summer temp.		Interior.		Summ'r temp.	Difference.
	Lat.	Long.			Lat.	Long.		
	° ′	° ′	°		° ′	° ′	°	°
Fort Humboldt...	40 46	124 9	57·4	Fort Reading	40 30	122 5	80·0	22·6
San Francisco....	37 48	122 26	57·3	Sacramento.	38 34	121 40	73·0	15·7
Monterey	36 36	121 52	58·6	Fort Miller..	37 0	119 40	85·5	26·9
San Diego.....	32 42	117 14	71·2	Fort Yuma..	32 43	114 36	90·0	18·8

3. Through about 20 degrees of latitude, the mean summer temperature of the Pacific coast is nearly constant, and indeed increases slightly in going from California to Oregon. This will appear from the following observations.

	Latitude.	Longitude.	Mean Summer temp're.	Years.
	° ′	° ′	°	
Monterey	36 36	121 52	58·6	5
San Francisco ...	37 48	122 26	57·3	4
Fort Humboldt, ..	40 46	124 9	57·4	1½
Fort Orford	42 44	124 29	59·9	2
Astoria	46 11	123 48	61·6	1
Sitka.....	57 3	135 18	54·2	7

4. The mean temperature of the California coast is nearly constant for six months of the year—from May to October,—and at some places the warmest month of the year is either May, September or October. This will appear from the following observations.

	May	June.	July.	Aug.	Sept.	Oct.	Years.
	°	°	°	°	°	°	
Monterey	56·8	57·8	58·5	59·6	59·3	58·4	5
San Francisco ...	55·3	56·8	57·9	57·2	58·3	57·9	4
Fort Humboldt...	55·3	58·6	56·7	57·0	57·0	53·0	1½

At Monterey in 1847, and also in 1850, September was the warmest month of the year; and in 1849 May was the warmest month. At San Francisco in 1853 and also in 1854, October was the warmest month of the year.

These remarkable anomalies respecting the temperature of the Pacific coast are at least in part explained by the prevalent westerly winds combined with the temperature of the neighboring ocean. The mean temperature of the ocean on the California coast in latitude 40°, during summer is 56°·5; which it will be observed is a little below the temperature of the coast stations given above.

The distribution of rain on the Pacific coast presents anomalies quite as remarkable as the distribution of temperature. At some places not a drop of rain falls for three months or more in succession, and the total fall for the year does not exceed from 3 to 7 inches; while other places are literally deluged with rain. This will appear from the following table, showing the fall of rain at sixteen stations near the Pacific coast.

	Lat.	Long.	Alt'e	May.	June	July.	Aug.	Sept.	Oct.	Spr'g.	Sum'r	Aut'n.	Win'r	Year	
	° ′	° ′	feet.												
Fort Yuma...	32 43	114 36	120	0·00	0·00	0·16	1·13	0·58	0·13	0·27	1·30	0·86	0·72	3·15	4
San Diego ...	32 42	117 14	150	0·57	0·15	0·01	0·39	0·03	0·05	2·74	0 55	1·24	5·90	10·43	5
San Luis Rey.	33 13	117 25	20	...	...	0·00	0·00	0·00	0·20	0·21	0·00	3·48	3 26	6·95	1
Del Chino ...	34 0	117 20	1000	1·14	0·00	0·00	0·09	0·00	0·00	4·59	0·09	1 67	7·42	13·77	2
Fort Tejon ...	35 3	118 48	1447	0·61	0·00	0·00	0·00	1·00	0·05	5·97	0·00	2·61	....	....	1
Monterey	36 36	121 52	140	0·53	0·13	0 08	0·00	0·01	0·33	4·43	0·21	1·65	5·91	12·20	4
Fort Miller...	37 0	119 40	402	1·36	0·01	0·01	0·00	0·05	0·16	9·57	0·02	2·80	9 79	22·18	4
San Francisco	37 48	122 26	150	0·48	0·02	0·00	0·01	0 07	0 63	8·81	0·03	2·75	11·25	22·84	4
Benicia.....	38 3	122 8	64	0·59	0·01	0·00	0·00	0·01	0·69	6·40	0·01	2·65	7 56	16·62	5
Sacramento ..	38 33	121 20	50	0·01	...	0·00	0·00	0·00	0·20	7·01	0·00	6 61	12·11	25 73	1
Camp Far West	39 7	120 18	150	0·86	0·00	0·00	0·00	0·36	0 06	10 66	0·00	2·40	6·79	19·85	1
Fort Humboldt	40 46	124 9	50	1·96	1·15	0·00	0·00	0·65	2·11	13·51	1·18	4 87	15·03	34·56	2
Fort Orford...	42 44	124 29	50	5·24	1·06	0·16	1·78	2·34	7·31	19·12	3·00	19·92	29 59	71 63	2
Astoria	46 11	123 48	50	5·95	2·85	0·00	1·15	1·87	6·70	16·43	4·00	21·77	44·15	86·35	1
Steilacoom...	47 10	122 25	300	1·86	1·97	0·34	1·54	2 67	4·43	11·19	3·85	15 83	22·62	53 49	6
Sitka.....	57 3	135 18	20	5 29	3·79	4·15	7 81	11·7	2·3.	18·32	15·75	32·10	23·77	89 94	7

Thus it is seen that for a period of two years no rain fell at Del Chino during the months of June, July, September and October, and only $\frac{9}{100}$ inch in August; that is, only $\frac{9}{100}$ inch for five months. At San Luis Rey no rain fell during the months of July, August and September. During May and June the observations are supposed to have been suspended. At Sacramento no rain fell during July, August and September. Only $\frac{1}{100}$ inch fell in May, and during June the observations appear to have been suspended. At Fort Tejon and Camp Far West no rain fell during the months of June, July and August. At eleven of the preceding stations, we find the aggregate fall of rain for five months of the year was less than one inch, viz. at Del Chino 0·09; San Luis Rey 0·21; Sacramento 0·21; Fort Miller 0·23; Camp Far West 0·42; Monterey 0·55; San Francisco 0·58; Benicia 0·61; San Diego 0·63; Fort Tejon 0·66; Fort Yuma 0·87.

The large amount of rain at Sitka, Astoria, and Fort Orford is nearly as remarkable as the absence of rain at places farther south. On the Atlantic coast in latitude 45°, the average annual fall of rain is about 36 inches.

All the facts with reference to the distribution of temperature and rain are palpably exhibited to the eye in a series of charts, for which Mr. Blodget deserves great credit. We cannot however avoid the impression that some of the anomalies which are indicated upon these charts will disappear when we obtain the mean of observations for a longer period of years.

It would afford us sincere pleasure if we could dismiss this volume with no other language than that of commendation; but a somewhat careful examination has convinced us that the execution of the work is not equal to its pretensions. We have marked a pretty long list of faults more or less serious, and some of these we propose briefly to mention. It may seem a superfluous act of fault-finding to criticise the literary merits of

a work devoted wholly to science, but we cannot avoid expressing our regrets that the literary character of this work should be such as seriously to impair the pleasure of a perusal. The style of composition is often harsh and even slovenly; many words are used in an improper sense: and it is frequently no easy matter to discover the author's meaning. We will illustrate these remarks by a few examples.

On page 89 Mr. Blodget speaks of "the Rocky Mountain plateau throwing out some exceptionable districts." We suppose he means exceptional districts. On page 487 he speaks of "the *rating* of instruments," that is, thermometers. We have often heard of *rating chronometers* and *verifying thermometers*, but never before heard of rating thermometers. On page 92 he says "the great plains of the Columbia River form a *climatological basin*." It has puzzled us not a little to ascertain what is a climatological basin. We can only guess that it must be a *basin having a climate;* but this does not remove the difficulty, for we are no less perplexed to determine what is a *basin not having a climate*. On page 345 he says, "As a *pendant* to the general notices of the quantity of water falling in the winter months, some distinctions should be made," etc. Here again we were forced to consult Webster and found eight significations of the word "pendant;" but after a strenuous effort to determine in what sense Mr. Blodget designed the word to be understood, we abandoned the attempt as fruitless. On page 348, he says, "the contact of *atmospheric volumes* with those altitudes induces precipitation," etc. We are not sure that we fully understand the force of the words we have here italicised, and we cannot avoid thinking that the phraseology is susceptible of improvement. Mr. Blodget makes very frequent use of the word 'symmetrical' as applied to the distribution of rain and heat. Often the word occurs several times on a single page, and frequently in such a connection as fails to convey to our mind any definite idea. In some instances we fancied the word was used in the sense of *uniform*, but we have searched our dictionaries in vain for any authority for such a use. As examples of the kind alluded to, we will refer to pages 346 and 347. Mr. Blodget frequently uses the word 'tone,' in a very peculiar manner. Thus on page 481 he says, "The demonstration of the constancy of the sun's heat cannot be undertaken here, and though it has not yet been made in any direct manner, the possibility of such demonstration will be admitted by all who would follow *that tone of proof*." If we could form any distinct idea of what 'that tone of proof' means, we might assent to the possibility of the demonstration referred to, but the meaning of the phrase could not be more effectually concealed if it were written in Chinese.

We will pass over a variety of passages in which there is apparently some typographical error, as on page 308 where the word "Observatories' should evidently read 'Observations;' but there is a large number of passages of which we are unable to divine the meaning, and where if there is any typographical error, it is not obvious what the error is.

On page 20 we read of "a record of meteorological observations mainly for the interest its startling phenomena gave, is a sort of interest it will never fail to have, and in which though having a philosophical air, *there can be no progress as positive science.*" On page 162, we read that "the *localization* of all the features of the climate is, from this point of comparison, the leading point of difference after that of the contrast in humidity." On page 355 we are told that "in a fluid mass which is aeriform the agitations are extreme in comparison with *its other conditions.*" On page 375 we are told that "the difference between the *distances* originating in the tropics as hurricanes, and the general rains originating inland, is merely one of degree." On page 519 we are told that "the winter and summer would mark these extremes of accumulation of heat first, and refrigeration next, were not each retarded by the operation of *laws inherent to the fluid or condition we designate as heat.*" We would respectfully suggest to the author that in case a second edition of the climatology should be called for, it would be desirable to add a few notes explanatory of the above passages.

Besides the class of passages already cited in which the meaning of the author is obscure, there is another class in which the meaning is apparently obvious, but which bear marks of having been written without due consideration. Thus on page 502 he says "the winter period is *always less* than that of summer;" but if we refer to the table on page 500 we shall see that out of 51 stations there mentioned, at 22 the winter is stated to be longer than the summer. On page 522, he says, "there must necessarily be much discrepancy in the *modes* of determining these points," viz: the days of maximum and minimum temperature. We suspect that the discrepancies referred to do not arise from differences in the *modes* of determination, but rather from the fact that some of the results are derived from short periods and others from longer periods of observation. On page 257 he speaks of "the isothermal lines as being more *definite* than a numerical quantity," that is, more definite than degrees of the thermometer. We have always been accustomed to consider the temperature of melting ice to be quite definite, and are surprised to hear that isothermal lines are *more* definite. On page 292 he says "there are *no sufficient data* for comparison with similar latitudes in Europe," referring to the first appearance of frost in autumn. We presume Mr. Blodget did not

intend to question the existence of such materials, but simply to state that they are inaccessible to him.

On page 156 he states that "the difference between the wet bulb thermometer and the temperature of the air sometimes reaches 30°." We have searched the book with considerable care in the hope of finding some particulars of these observations, but in vain. We do not intend to express any doubt of the accuracy of the above statement, but we think that a degree of dryness so remarkable is worthy of a more extended notice. On page 396 he says that "at Goldsborough, N. C., *snow fell for an hour or more* on the evening of Sunday, Aug. 31st, 1856." Among the many remarkable facts stated in the Climatology, this is one of the most remarkable, and we think Mr. Blodget should have been more careful to give his authority for the statement. On page 482 he says, "It is *certain* that no changes of subsidence, elevation, or continental outlines are now in progress." We cannot help regarding this conclusion as the most important addition which has been made in modern times to the science of geology. Perhaps some would question it.

On page 481, he says, "Laplace has shown that the mean temperature of the mass of the earth cannot have changed in any appreciable measure *within the entire period embraced by astronomical calculation, and that none can occur*, while the planetary movements remain what they now are." And on page 484 he adds, "Laplace has shown that the heat of the earth cannot have changed *for the vast period over which astronomical calculation can reach.*" In order to comprehend the full force of this statement we must know how vast are the periods over which astronomical calculation *can* reach. The period of time to which astronomical calculations can reach is not limited to ten thousand years, nor a hundred thousand or a million of years; we can assign it *no* limit. If we enquire for the periods over which astronomical calculations *have* actually extended, we shall find them sufficiently long. Leverrier has computed that the eccentricity of the earth's orbit will continue to diminish during the period of 23,980 years. See Connaissance des Temps, 1843. Laplace found that the eccentricity of Jupiter's orbit has a variation whose period is 35,000 years. Lagrange found that the secular inequalities in the mean motions of Jupiter and Saturn extended to the period of 70,414 years. The secular inequality in the moon's mean motion has a *much longer period* than this. See Grant's History of Physical Astronomy, page 63.

Now Laplace has shown that the mean heat of the earth cannot have changed sensibly in 2,000 years, and *that is all.* He *has not shown* that it may not have changed sensibly in 10,000 years, and geological phenomena unequivocally prove that the temperature *has changed sensibly* within a period which is *not long when*

compared with the entire duration of the earth. Mr. Blodget's statement is here most seriously in error.

On page 356, it is stated that Professor Dove has expressed his dissent from the generally received theory of the trade winds, which theory requires a belt of prevalent westerly winds in the middle latitudes of the temperate zones. This statement has excited our unqualified surprise. In a volume published by Professor Dove in 1837 entitled "Meteorologische Untersuchungen" he has given a very full account of the trade winds and of the prevalent westerly winds of the temperate zones, and endorses in unequivocal terms the common theory on that subject which was first distinctly stated by Hadley. In his preface to that volume page v, Prof. Dove says, "In the year 1730, Hadley established a theory of the trade winds founded upon the rotation of the earth and the unequal temperature of the different latitudes, *which even in the details of the phenomena has shown itself to be the true theory.*" (Welche sich selbst im Detail der Erscheinungen als *die richtige* bewährt hat.) Those who are familiar with the writings of Professor Dove do not need to be informed that the same general views of the trade winds are expressed in all his memoirs upon this subject since 1837. The passage which Mr. Blodget quotes from one of Dove's memoirs was never designed to convey the idea which Mr. Blodget has imputed to it. Professor Dove merely insists that there may be local exceptions to the general law of prevalent westerly winds in the temperate latitudes, as there are local exceptions to the general law of the trade winds in the torrid zone. We assure Mr. Blodget that he has misrepresented the views of Professor Dove quite as seriously as he has the labors of Laplace.

We come now to notice a class of faults which affect more seriously the scientific character of the work. Mr. Blodget has treated somewhat briefly of tornadoes; of the winds; of the cause of rain, and of seasons of unusual cold; as well as of the laws of our winter storms.

On page 400, he mentions several cases of heavy weights being lifted up by the force of hurricanes in the West Indies. In one instance "a piece of lead 4000 pounds in weight was lifted and carried 1800 feet," and he adds, "other agencies than simply the force of wind must account for these extraordinary cases of lifting weights, and *the convective electric discharge is an obvious and adequate solution of the facts.*" If Mr. Blodget had closed this sentence with the word *perhaps*, it would have seemed more appropriate than in some cases where so introduced. See pages 144, 308, etc. As he has not given the reason for his opinion we shall not enter into any argument on the subject, but content ourselves with recording our firm conviction that electricity in any form *does not afford an adequate solution of the facts.*

On page 402, he says that "tornadoes are often evolute, throwing trees *outwardly* from the centre, instead of inward." We will not deny that the centre of a tornado often vibrates to and fro across the line of progress, giving sometimes the appearance of trees thrown outward from the centre; but that the force of a tornado is ever *really* exerted in a direction *from the centre*, we do not believe, and we challenge Mr. Blodget to the proof. On page 403 he says, "the permanence of a forest trace of a tornado could be relied upon *for at least five hundred years*." Mr. Blodget may have evidence on this subject of which we are ignorant, but we confess we are very skeptical.

On page 355 Mr. Blodget expresses great contempt for the winds, and says "they deserve much less attention than has heretofore been given them in observation, and in general deductions they might even be omitted entirely." We think his indifferent success in studying the laws of storms, to which we shall presently refer, may be ascribed in some degree to his low estimate of the agency of winds. We find it difficult to reconcile the views which he has expressed on the subject of winds on different pages of his book. On page 382 he says "None of the winds [of the United States] from other than westerly points are winds of *propulsion*, or propagated from their apparent point of origin—they are all, including a portion from the west, winds of *aspiration*." Now as throughout nearly the whole of the United States, the prevalent winds are from the west, we should infer from the preceding statement that Mr. Blodget intended to pronounce at least one half of all our winds to be winds of propulsion. But on page 372 he says, "there is *little evidence of the existence of any winds of propulsion*;" and on page 361 he says "*no such winds* [as winds of propulsion] *are now recognized anywhere* indeed." It would be interesting to know how these different statements are to be reconciled.

Mr. Blodget's views of the origin of rain are quite original. These views are not given in a very complete and systematic form, yet some general idea of them may be derived from the following extracts. On page 358 he says, "the higher strata of clouds come uniformly from some westerly point. The lower clouds are from various points, two strata of different movement often lying beneath that from the west, yet *the stratum from a westerly point usually deposits the rain*." On page 359 he says, "the rains of the eastern United States fall mainly from the upper or westerly cloud, in all cases." On page 360, he says, "the water must necessarily fall from the upper cloud. It is impossible that such a storm should receive its principal supply of water from any other source than the mass of air moving from the west. The prevalent westerly winds must therefore be largely charged with vapor, and must exhibit a nearly constant

precipitation either as clouds or rain." On page 367 he says "the high rain-bearing clouds are borne on a westerly current for all seasons." It seems clear from these extracts that Mr. Blodget means to convey the idea that the moisture which is precipitated in the form of rain comes almost exclusively from that high stratum of air which throughout New York and New England moves almost invariably from the west. The cause of this precipitation is hinted at on pages 391 and 2, where he says "this class of storms [winter storms] originate in changes of the measures of heat and moisture introduced from *exterior sources.* The presence of a rarefied and humid mass, from which *rain will fall profusely by the natural loss of temperature* which must ensue after a brief presence in the temperate latitudes, will induce condensation first, winds from adjacent areas next."

Let us give this theory of rain a moment's attention. This upper stratum of air whose westerly direction is not interrupted by the easterly winds which prevail at the earth's surface during a violent winter storm, is the upper half of the atmosphere, and its lower limit may be estimated at not less than three miles in elevation. The mean temperature of the surface of the earth in the month of January on the parallel of 40° is about 32°. The decrease of temperature as we ascend is about one degree of Fahrenheit for 300 feet; or 53 degrees for an elevation of three miles, making the mean temperature of January in lat. 40° at the height of three miles $-21°$. In order however that we may not be suspected of exaggeration, we will assume the temperature to be that of zero. Now at zero of Fahrenheit, the elastic force of vapor of water is equal to $\frac{6}{100}$ inch of mercury, or less than one inch of water; that is, if air at the temperature of zero were saturated with vapor, and *every particle of the vapor were precipitated,* it would cover the earth with less than one inch of water. Now it not unfrequently happens in one of our winter storms, that over a circle of 500 miles in diameter, the average fall of rain exceeds one inch. It is very evident then that the upper stratum does not furnish the rain which falls in our great storms, for the simple reason that more water falls than was ever contained in that stratum; and moreover it is highly probable that this upper stratum contains well nigh as much moisture at the conclusion of a great storm, as it did at the commencement.

Mr. Blodget's views of the cause of seasons of extraordinary cold are also peculiar, but his conclusions are not stated with very great clearness. On page 307 he says, "the origin of these non-periodic oscillations is *exterior to the continent,* and they have no progressive movement. In no case is it apparent that these cold extremes come from the north, or are caused by north winds, or an inflection of the polar atmosphere southward." Mr. Blodget is confident that the origin of seasons of unusual cold

(as for example the winter of 1856,) is exterior to the continent —that is, it *does not come* from the continent; but we cannot find that he has any where intimated from what point it *does come.* As Mr. Blodget appears to entertain some respect for Professor Dove, we will extract a single sentence from Dove's 'Essay on the Distribution of Heat over the surface of the Globe,' page 18. "The different degree of severity in the winters of different years, depends *so evidently* in our latitudes on the prevailing direction of the wind in each case, that *there can be no doubt* as to the more immediate or proximate cause of this diversity."

Mr. Blodget regards the subject of winter storms as worthy of very little attention. On page vii. he says, "the surface dynamics are of very little importance." On page 394 he assigns a reason which if substantiated would entirely warrant the above conclusion. He says, "Forcible as the evidences of dynamic agency appear in this class of storms it is believed that *they are not subject to such laws.*" And again on page 391, "This class of storms originate in changes of the measures of heat and moisture introduced from *exterior sources*, and these changes are absolutely non-periodic and *cannot be foretold.* The ceaseless oscillations in the measure of heat and of aqueous vapor in the air of temperate latitudes from exterior causes, must render the computation of the elements of a perturbation so induced, *utterly beyond calculation;* since the primary and indispensable elements of the change are *beyond the possibility of being known.*" This is a gloomy picture of the prospects of meteorology.

He however mentions some conclusions which we regard as of great importance with reference to the phenomena of storms. On page 195 he says, "On the Pacific coast, rain always begins earlier at the northernmost stations than at the next southward; and on page 381, he says, "the general winter storms of the United States come from a point north of west at the Mississippi river." If Mr. Blodget means by these statements that in our ordinary winter storms on the Pacific coast and near the Mississippi river on the parallel of 40 degrees, the point of greatest barometric depression travels from northwest to southeast, we confess that this is something new to us, and invite him to name a case and produce his testimony.

On page 387 Mr. Blodget states that about the 1st of January, 1855, storms were experienced well nigh simultaneously on the Pacific coast, throughout the Mississippi Valley, along the Atlantic coast, in England, on the Baltic Sea, and even to the East Indies and the Sandwich Islands; and seems to intimate though in a somewhat guarded manner, that all these constituted in effect but one great storm. If Mr. Blodget can identify a single storm, tracing its progress clearly from day to day over half the distance here named, he will accomplish what no one has hitherto succeeded in doing.

On page 132 Mr. Blodget says, "The great winter storms are special proofs of the uniformity of the field over which the mass of our atmosphere, and the elements of heat, moisture, and *perhaps magnetism* which move it, pass through their succession of changes." If Mr. Blodget can show any necessary connexion between our winter storms and the phenomena of terrestrial magnetism, he will make a positive addition to the science of Meteorology, and will have done something to show that storms are subject to *laws*.

On page 380 he says, "In the colder months the change of condition, both as regards temperature and the quantity of aqueous vapor suspended, affects the whole mass in greater degree than when the rain is deposited in showers. For this reason the range of the barometer is greater, and this range is a very direct measure of the relative condition, so that *the readings may be taken as simple representatives of the quantity of heat and moisture present compared with the average.*" Mr. Blodget here seems to advance the doctrine that the oscillations of the barometer which are so common in winter are adequately explained by the changes in the temperature of the air and in the amount of aqueous vapor. If this is Mr. Blodget's view, we differ from him totally. Changes in the temperature of the air and in the amount of aqueous vapor, would doubtless cause changes in the height of the barometer; but these causes are *inadequate* to explain the actually observed oscillations of the barometer. In some parts of England the observed range of the barometer is 3½ inches, indicating a variation of pressure to the amount of over *one ninth* part of the whole quantity. During tropical hurricanes the barometer has been observed to fall *about two inches in three or four hours.* It is easy to show by numerical computation that no admissible supposition respecting variations of temperature or moisture will account for such extreme oscillations of the barometer. Moreover it is not uncommon in Europe for a fall of the barometer to be accompanied by a fall of the thermometer; so that the barometer may even fall in spite of *an increased specific gravity of the air.*

In conclusion, we will sum up our judgment of the Climatology in a single sentence. The field which Mr. Blodget has occupied is a new one, and portions of it have hitherto been wholly unexplored—Mr. Blodget has enjoyed unusual advantages for this research from his connection with the Smithsonian Institution, and the Surgeon General's office at Washington; and we regard his isothermal and rain charts as constituting an important addition to the science of Meteorology: but his book is loose in style and often obscure; it contains many careless and sometimes erroneous statements: and the views which it embodies respecting the causes of the most common meteorological phenomena are radically erroneous. X.

ART. XXIV.—*Preliminary notice of a new base containing Osmium and the elements of Ammonia;* by WOLCOTT GIBBS and F. A. GENTH.

AN investigation of the ammonia-cobalt bases, the results of which have appeared in this Journal, has led us to direct our attention to the production of similar compounds with other metals. We have in particular studied the action of the mixed oxyds of nitrogen, NO_2, NO_3, and NO_4, upon ammoniacal solutions, and have obtained results which will form the subject of a future communication. In the course of an extended study of the platinum metals, for which we have enjoyed peculiar facilities, we have remarked that osmium forms with ammonia a well characterized base, all the salts of which appear to be highly crystalline.

The chlorid of this base is a yellow crystalline salt first obtained by Fremy in 1844, and described in his memoir* on the metallic acids, under the name of osmiamid. To this body Fremy attributes the formula $NH_4Cl+OsO_2.NH_2$, according to which it is to be viewed as a compound of chlorid of ammonium with an amid of osmious acid.

We have however found that the substance in question is a true chlorid which yields a beautiful salt with bichlorid of platinum, and which by double decomposition with salts of silver enables us to form a well defined sulphate, nitrate, oxalate, &c. The best method of forming these salts however is precisely that which Fremy employed for the chlorid, and consists in adding a solution of osmite of potash to a cold solution of an ammoniacal salt, when the new salt, is immediately formed and crystallizes from the solution.

The salts of the new base have a very beautiful orange yellow color. They are nearly insoluble in cold water; hot water dissolves them more readily, but the solutions are easily decomposed with evolution of osmic acid. We are not as yet prepared to pronounce with certainty upon the constitution of these salts, the analyses being difficult and tedious. We may however remark that Fremy's analysis of the chlorid appears to be correct, and that we attribute to it the rational formula

$$2NH_3.\overset{\frown}{Os}O_2, Cl,$$

according to which the base will be uniacid. The results of our complete investigation will form the subject of another communication. Iridium and Rhodium form with ammonia and deutoxyd of nitrogen bases analogous to Xanthocobalt, with the study of which we are also occupied.

* Annales de Chimie et de Physique, 3d series, vol. xii, p. 521.

Art. XXV.—*Review of the Operations and Results of the United States Coast Survey.*

[Concluded from p. 83.]

The publication of maps and charts constitutes, as may be supposed, one of the main objects of the survey. Upon the preparation of these an immense amount of labor is bestowed, the value of the work consisting chiefly in the accuracy of the details. In fact the whole subject may be fairly considered as constituting a special branch of science, with a system of signs and a mode of expression peculiar to itself. The most advantageous methods of presenting to the eye an easily intelligible view of the topography and hydrography of the coast have of course occupied a very large share of attention. The general treatment of the subject, the arbitrary signs and other details being once settled, and the triangulation and plane-table work being finished, the maps are drawn and the work of the engraver begins. In order to render the results of the survey useful and accessible as soon as possible, and at the same time to exhibit the progress of the work, three classes of charts are engraved. These are termed sketches, preliminary charts, and finished charts. The sketches are of two kinds; progress sketches showing from year to year the advance of the work, and sketches of parts of the coast whether connected or detached. These are generally engraved by apprentices in the office of the survey and serve as subjects for practice. They are added to, year by year, and lithographic transfers published in the annual reports. In this manner it rarely happens that a year elapses between a survey and its publication in some useful shape. The preliminary charts serve nearly the same purpose as the sketches, but are larger and more finished.

The finished charts are divided into three classes. The first are called inshore or coast charts, and are drawn to a scale of $\frac{1}{80,000}$. They embrace the shore line, the interior as far as the nearest main road, and the hydrography for about fourteen miles from the shore. The second class embraces what are termed offshore or general coast charts, drawn to a scale of $\frac{1}{400,000}$, giving the shore line and the general topography of the coast, so that it may be recognized by the navigator, but omitting minute details and giving the soundings to the depth of at least 120 fathoms. The third class is composed of minutely detailed charts of harbors, anchorage, &c., exhibiting the sounding, tides and currents, the outline of the shore, the topography of the adjacent country, in short, presenting the complete results of the survey. These charts are drawn on scales varying from $\frac{1}{5000}$ to $\frac{1}{80,000}$.

The finished charts require the work of first class engravers. These are so difficult to procure that in spite of the urgent necessity of the case and the unceasing efforts of the superintendent, there were but four first class engravers in the office at the beginning of the year 1856. Even these were only obtained by a special agent sent to Europe for the express purpose. With a wise liberality the charts are sold at the lowest possible rates, while the gratuitous distribution of the annual reports of the Coast Survey gives a still wider circulation to its graphical results.

As the greater number of maps and charts are engraved upon copper, and as the softness of this metal renders it impossible to obtain more than a limited number of impressions from a single plate, a method of reproducing the plates themselves becomes indispensable. Such a method is found in the electrotype process, which is now applied in the office of the survey upon a very large scale, and which has there received a development and a perfection which leaves little to be desired. We believe that we hazard little in asserting that as regards the thickness and quality of the metal precipitated, the size of the plates, the prevention of adhesion between the original plate and that deposited, and the absolute command of the whole process, the electrotype operations of the Coast Survey are unequalled in any country.

It has very recently been found possible to print from thin electrotypes merely folded over the edges of a stout plate of metal which serves as a support or back. In this manner plates of the first quality can be furnished for about one-third of the cost of those deposited of the usual thickness. Processes are also employed by which small plates can be pieced out in any direction and to any desirable size, no line of junction being visible between the original and the addition.

The particular apparatus and arrangements employed in the electrotype department have nearly all originated in the department itself, and have been fully described in the annual reports of the survey and in this Journal. It cannot be doubted that they have exerted a positive influence upon the progress of this branch of art.

It was just that an elaborate and complete survey of the phenomena of the Gulf Stream should be executed by a descendant of Franklin, and it may well be conceived that the peculiarities of that magnificent current, alike interesting from the practical and the scientific point of view, have engaged a special share of attention. In accordance with the direction of Congress that a map exhibiting the state of our knowledge of the Gulf Stream should accompany the report of 1853, the work of investigation was pushed forward during that year and results of great inter-

est obtained, and illustrated in two charts appended to the report. These results show that the Gulf Stream is not, as generally supposed, a single broad current of warm water flowing in a northeasterly direction, but that it is in reality an aggregate of separate currents alternately cold and warm, and exhibiting a certain degree of parallelism. The method of examination employed was the very obvious and natural one of running numerous sections across the Stream and observing the depth of the water and the temperature at different depths. The number of positions observed in each section was made to depend upon the more or less rapid changes of temperature, and the temperatures were observed at the surface and at depths of five, ten, twenty, thirty, fifty, seventy, one hundred, one hundred and fifty, two hundred, three, four, five and six hundred fathoms, so as to reach into the cold polar currents lying beneath. In this manner ten sections were surveyed, the temperatures being determined for moderate depths with Six's self-registering thermometers, and for greater depths with Saxton's metallic thermometers. If we employ the term Gulf Stream in its broadest sense and understand by it the aggregate of *all* the warm currents flowing from the Gulf of Mexico into the north Atlantic, a glance at the Coast Survey map shows us at once the existence of at least four distinct warm currents separated from each other by cold bands, a fourth cold band separating the first or inner warm band from the shore. Each warm band is narrowest and warmest in its most southerly section—that of Cape Canaveral—and becomes broader and cooler in its progress northward and eastward, while its boundaries become less and less clearly defined. The most cursory observation shows that these bands are parallel to the outline of the coast, and that as we recede from the shore upon any section they become broader, cooler, and less sharply separated from the intervening cold masses. The Gulf Stream proper forms the second warm current in order from the shore. As might naturally be expected from its greater density the colder water tends to occupy the lowest position, but instead of forming a level plateau it follows the irregularities of the bottom. This again determines the vertical distribution of the warm currents, and we find accordingly that in each section, as far as examined, the curves which represent the depths corresponding to equal temperatures are sensibly parallel to the contour of the bottom. This fact is well illustrated on the Charleston section, where the bottom of the ocean exhibits remarkable irregularities. Thus the depth on this section gradually increases to a distance of fifty-three miles, when it suddenly descends to upward of six hundred fathoms. Ninety-six miles from the coast we find a range of hills, having a height of eighteen hundred feet and a base of about eleven miles on the seaward side.

One hundred and thirty-six miles from the coast occurs another range of hills fifteen hundred feet high and twenty-eight miles base toward the shore, and six hundred feet high with a base of about seventeen miles on the outer side. Beyond this there is a more gradual rise. Now the forms of the curves of equal temperature resulting from multiplied observations at different depths along the section correspond exactly to the outline of the bottom.

Perhaps the most remarkable peculiarity of the Gulf Stream is what has been appropriately termed the "cold wall," a mass of cold water lying between the warm water and the shore, and sharply defining the inner boundary of the great current. The change from the warm water of the stream to the cold body of water inside of it toward the shore, is particularly sudden and well marked in the northern sections, but may also be easily distinguished south of Cape Hatteras. In the cold water inshore from the Gulf Stream a current setting southward has been observed, as also in the cold band outside the axes. It is not yet certain however that these are permanent currents.

Another remarkable fact is observed in comparing the temperatures of the northern and southern portions of the Gulf Stream. Taking the maximum temperatures at twelve or fifteen fathoms beneath the surface, there is, as a general rule, an increase of temperature in passing southward. But in successive years we find the highest temperature at twelve fathoms, on the Cape Henry section, higher than at Hatteras, while the temperature in the axis of the stream at Sandy Hook in July, 1846, was higher by five and one half degrees than at Charleston in June, 1853. The underlying polar currents are as distinctly marked in the southern as in the northern latitudes. Thus in latitude 37° 20′ the temperature at a depth of four hundred fathoms below the warmest water of the Gulf Stream in August, 1846, was 49° Fahr., while in the same position in latitude 28° 20′ it was 48½° Fahr. The fact that the side limits of the polar current recede from the shore as the depth increases is clearly marked on all the sections.

It is hardly necessary to observe that much remains to be done to complete the survey of the Gulf Stream. But it may be justly asserted that the results obtained by the Coast Survey have placed the whole subject in an entirely new point of view and have contributed greatly to the solution of one of the grandest problems in physical geography. It may be remarked in this place that the most recent observations fully confirm the theory of Franklin that the Gulf Stream makes a complete circuit in the Atlantic, returning again to its source. A branch of the main current is however thrown out toward the coasts of Ireland and Norway, and is thence reflected toward the Arctic ocean. This branch appears to offer the most feasible passage

to the open polar sea, to the discovery of which so much attention has been recently directed, and which appears to be in fact only a forgotten reality.

We have adverted to the observations of latitude, azimuth and longitude as requisite to determine the position on the earth's surface of the stations, the relative situation of which as to distance and direction is ascertained by triangulation. They serve thus incidentally to determine the *figure* of that portion of the earth over which the work extends. While in other countries extensive operations have been executed for the special purpose of measuring arcs of meridians and parallels, the Coast Survey furnishes those important additions to one of the highest departments of physical knowledge, without any expenditure not absolutely necessary for the perfect attainment of its most direct and practical objects. An individual arc of $3\frac{1}{2}$ degrees from Nantucket to Mt. Blue in Maine—another of $2\frac{1}{2}$ degrees from the head to the capes of Chesapeake Bay, which may be extended $1\frac{1}{2}$ degrees farther to Cape Hatteras, and an arc of the parallel extending 4° from Nantucket to New York are among the results already obtained. They exhibit a general conformity to the elements of the earth's figure deduced from all previous measurements, while they show marked local variations which have become the subject of special study.

These variations in the direction of the plumb-line are found to be not only such as would result from want of uniformity in the geological structure in the immediate vicinity of stations, but to extend like undulations over considerable regions.

In order to obtain these "station errors" as free from residual instrumental errors as possible, the capabilities of various instruments and methods for determining latitude have been successively tried, large vertical circles, repeating circles, the prime vertical transit, the zenith telescope (or equal altitude instrument), and Airy's zenith sector. The latter instrument is the most perfect of its kind, possessing many improvements on the zenith sector of the British Ordnance Survey, the only other of the kind in existence. The accuracy of its results, however, is rivalled by those of the zenith telescope, the application of which to observations of latitude by equal meridian altitudes of stars to the north and south of the zenith is of American origin and has been greatly perfected in the Coast Survey. Combining portability and facility of use, with great accuracy, it has become the favorite instrument, and no observer, who has ever used it, is willing to return to others.

In order to bring out the various elements of error, observations have been made at the same stations with different kinds of instruments, with the same instrument by different observers, and by the same observer with two different instruments of the

same class. By a consistent application of the method of least squares, the observations have been severely scrutinized, and their relative values determined without the admission of anything like arbitrary preference.

Looking at the observations of azimuth we again find the Coast Survey testing the relative value of known methods and perfecting them or devising new ones, not only *proving* but *improving* all. Abandoning the methods by observations of the sun at low latitudes and by transits of stars over the verticals of stations, as involving too largely the difficult element of *time*, the observations of azimuth have been made principally on close circumpolar stars, especially the pole-star. The reduction of observations made near the time of the star's greatest eastern or western elongation, has been greatly facilitated by the use of a simple formula. An elegant method has been introduced, of observing the star at corresponding equal times before and after either culmination, by which arrangement the labor of computation is almost entirely saved, the mean of each pair of corresponding observations giving at once the meridian. The observations of azimuth have shown irregularities to exist in the direction of the plumb-line similar in kind and amount to those indicated by the latitude observations.

One of the most important and striking features of the methods of the Coast Survey is the total absence of eclecticism, which in former times was an acknowledged principle with observers, and to which there is even now a strong leaning in some quarters. The observer may indeed choose circumstances favorable to his purpose and may affix to the observations a statement of facts affecting their quality, but here the influence of his judgment or bias ceases. The observations are made to tell their own story, and by the searching test of the method of least squares their relative weight is ascertained, and rejections, if necessary, are made according to Peirce's criterion. The step is taken or combination made; but the reasons for it are such as to be necessarily arrived at by every one, according to the principles laid down. All observations are liable to more or less uncertainty, and there are probably classes of errors which no number of observations or variety of methods can entirely eliminate; it will always be necessary to discriminate, and to apply small corrections to the results in order to make them fulfil the theoretical relations existing between them. When this is done according to fixed mathematical rules all uncertainty vanishes, and truth must be the gainer, while on the other hand when it is allowed to be done according to personal judgment or bias, results must vary with different computers, and the door is opened to falsification and fraud.

The Coast Survey is at present under the general control of the Treasury Department, which appoints its officers and regulates their compensation. The Department furthermore authorizes all expenditures, approves the plans and estimates of the superintendent, and makes general regulations for the work under the law. The immediate agent of the Treasury Department is the superintendent, who arranges the plan of conducting the work, attends to its business details, issues instructions for its execution, and is responsible for the scientific accuracy of the whole. All persons and parties employed report directly to the Superintendent, who in turn presents an annual report to the Department, offering a complete and detailed account of the work done during each year. The annual reports are amply illustrated by maps and charts, and are extensively and gratuitously distributed. The distribution is made by the assistant in charge of the office who has all the reports in his possession and who distributes them according to a prepared list.

In addition to the laborious duties of the general direction of the survey, and inspection of the parties, the Superintendent himself personally assists in the execution of the work, taking the field and making observations as required. The different parts of the work are entrusted to assistants who act as directed by the Superintendent and are responsible to him, the office of the survey being considered as a party with an assistant in charge. Each field party consists of a chief, who may have one or more assistants, and of several hands. In the office, computers, draughtsmen, engravers, printers, mechanics, clerks, &c., are employed as occasion may require.

In the organization of the survey three classes of persons are recognized by law. These are civilians, officers of the army, and officers of the navy. The civilians form the permanent nucleus of the survey. Their salaries are under the control of the Department, and they are promoted or lowered according to their merit as measured by the results of their work. As they are not, save only in exceptional cases, subject to frequent changes, they form a constantly efficient and trained body and preserve uniformity in the business and methods of the survey. Such a nucleus is obviously indispensable as the whole work might otherwise be disorganized by calls for the professional services of officers of the army and navy. Thus on the breaking out of the Mexican war all the officers of the line of the army and part of those of the staff, serving on the Coast Survey, were detached for active military service.

The officers of the army and navy are detailed by the heads of their respective departments on the application of the superintendent through the Treasury Department. They receive no extra emolument from the Coast Survey and are of course liable

to be frequently changed. Their employment is, however, very advantageous both to the Survey and to themselves, since they furnish to the former active, intelligent, and zealous assistants, while they of course profit by the peculiar scientific training offered in the service to which they are detailed.

In fact it is easy to see that there is no part of the hydrography or of the topographical surveys which does not furnish advantageous practice to an officer in either branch of the service. The topographical engineer finds employment in his own department. The survey of harbors and the study of tides, currents, shoals, entrance channels, and all those peculiarities which distinguish the different seaports, are of the utmost importance in determining the proper sites for fortifications and permanent defenses. They furnish weapons of offense as well as defense. In the recent European war the success of several important operations depended wholly upon the skill and promptness with which surveys were executed by naval officers. But even in time of peace the advantages of having on board of every ship thoroughly trained hydrographers can hardly be overestimated, for commerce, and therefore civilization, profits by every new harbor surveyed, every channel sounded, every current whose course and velocity are traced. The law requires that as many officers of the army and navy be employed as may be compatible with the successful prosecution of the work.

The work of the Coast Survey is naturally divided into field and office work. The field work consists in the actual surveys and observations of various kinds and is either original or of verification. The methods of conducting the work are laid down in general instructions by the superintendent who also directs what scientific processes and instruments are to be employed. The assistants make monthly reports in prepared forms and keep daily journals which are placed on file in the office. A general report is also made to the superintendent on taking and leaving the field, and in the month of October of each year for the annual report.

The office work consists of computing, drawing, engraving, printing, &c., and is for the most part under the care of the assistant having charge of the office. The publication and distribution of maps and the care of the accounts and property are placed in the charge of the general disbursing agent who gives bond to the Treasury Department.

The minute attention required to secure accuracy in the computations of the Coast Survey is well exhibited in the system of checks employed. The field parties in the first place compute their own work and a second computation is then made independently by persons having no connection with the field work. The assistant in charge of the office then examines and com-

pares the two computations and reports any discrepancies to the superintendent for examination. The records of observations and calculations are put in form for publication by the assistant in charge of the office under the direction of the superintendent, but the records and results now publishing as a separate work are under the charge of a special officer. Drawings are first executed by the field parties and reductions of these to the scale of publication are then made by regular draughtsmen in the office, and these drawings are finally revised and verified. It is almost needless to mention that all the topographical signs, forms and sizes of letters, &c. are prescribed by rule so as to be uniform. This subject, as already mentioned, is one which required special study. Thus the scale of shade is made to express the degree of slope by the strength of the hachure lines and the distance between them. The engraving of the maps and charts is under the charge of an assistant who verifies all engraved maps; from him they pass to the assistant in charge of the office who finally reports them to the superintendent.

The prices of the maps and charts are fixed by the Treasury Department upon the general principle that the sale should pay for the cost of paper and printing. The small maps are sold for fifteen and the larger for twenty to fifty cents. Besides the distribution by sale many copies are forwarded to literary, scientific, and commercial institutions, as designated by the Treasury Department.

In all cases the original records of observations and field work are transmitted to the office after duplicates have been made by the field parties. These are deposited in a fire-proof building in charge of the general disbursing agent. The instruments belonging to the Survey, properly marked and numbered, are also deposited in a fire-proof building, the repairs being almost always executed in the office.

The general estimates for the Survey are made by the superintendent who controls the expenditures for field and office work. On receiving his instructions for work, which usually state the limit of expenditure, the assistant makes an estimate for the number of hands required and for the general expenses of his party. This estimate, after the approval of the superintendent, is the authority of the disbursing agent in settling the accounts. The rules of the work require that a voucher in the form of a receipt be presented for all sums exceeding one dollar.

The chief of each party keeps an account of the party disbursements and transmits it to the general disbursing agent who supplies funds, audits accounts, and is responsible to the Treasury Department.

Beside the very numerous duties of supervision and of personal exertion which are discharged by the superintendent, there

are many special subjects which are under his immediate direction and in charge of a special assistant. Such are the researches upon the tides and the Gulf Stream; the preparation of the records and results for publication; the longitude work both astronomical and telegraphic; experimental researches on various practical subjects bearing directly upon the survey; the expansion of paper and the various modes of making and preparing it; the covering of copper plates with surfaces of iridium; improvements in different kinds of engraving, and other matters too numerous too mention.

The amount of labor, skill, and care required to maintain the harmonious action of the different parts of an organization like that of the Coast Survey may easily be imagined, and we may not unreasonably ask how many scientific men in our own, or in any other country, possess the extent and variety of knowledge combined with the tact and the executive capacity which such a work demands, and which it has called forth.

The Coast Survey is a national work of which we may well be proud. No other geodetic operations have ever been conducted upon so gigantic a scale, or have yielded such fruits of usefulness and honor. The work is worthy of the national spirit which originated it and which it illustrates. It is one of the great ideas which we have carried out. Like every great work it has a permanent value, and if national in conception and in execution, is universal in its example and its utility. It is estimated that if the annual appropriations are continued upon the present scale, the survey can be completed in about twelve years. May we not hope that it will continue to command the sympathy and support of every patriot, and that it will be permitted gloriously to complete that which has been so worthily begun.

ART. XXVI.—*Description of New Carboniferous Fossils from the Appalachian, Illinois and Michigan Coal-fields;* by R. P. STEVENS.

BELLEROPHON.—*B. globosa*, n. s. Shell globose, symmetrical. Ears extended and partially enrolled around a small umbilicus. Outer lip moderately inflated. Sinus wide. Pillar lip smooth, scarcely projecting into the mouth of the shell. Surface, exhibiting ridges, extending from one umbilicus to the other, slightly curved backwards on the dorsum. No carina. Width 0·7 of an inch, height 0·6 of an inch.

Geological position. In the upper shales of the coal measures, associated with B. urii, B. percarinatus, Myalina subquadrata, Pleurotomaria virgillati, and other carboniferous fossils.

Locality: Lasalle, Ill.

Aclis (Loven).—1. *A. minuta*, n. s. Shell turreted, elongated, slender. Whorls 10, rounded, gradually diminishing to the apex and ornamented (on the body whorl) with 12 very minute longitudinal lines, which are stronger on the lower half of each whorl. Apex polished. Length 0·2 of an inch, width (body whorl) 0·05 of an inch.

Position and locality: roof of the Danville, Ill. coal seam, which is the third in the ascending series.

2. *A. robusta*, n. s. Shell turreted, tapering. Whorls 7, body whorl more robust than the others, one-third as wide as the total length of the shell. Ornamented with longitudinal lines, which are obsolete on the upper side of the apicial whorls. Pillar-lip curving outwards to meet the labrum, which is thin and regular and united to the body whorl at right angles.

Dimensions: length 0·3 of an inch, width of body whorl nearly 0·15 of an inch.

Position and locality as the preceding.

Chemnitzia (D'Orbigny).—*C. attenuata*, n. s. Shell turreted, elongated, slender. Whorls 12, flattened, regularly diminishing until lost in a smooth, minute apex. Whorls exhibiting numerous scooped indentations, which are continued to the upper edge of each volution, giving at the suture a nodulated appearance.

Dimensions: length 0·3 of an inch: body whorl, width 0·1 of an inch.

Position and locality as the preceding.

Loxonema (Phillips).—1. *L. Newberryii*, n. s. Shell robust, elongated, spire tapering and acute. Whorls 8, slightly rounded and exhibiting, under the glass, minute oblique striæ. Body whorl, scarcely inflated, once and a half as long as the spire. Apex minute, polished. Columella with two distinct folds, with a corresponding groove between them and gently prolonged to meet the outer lip at an acute angle. Labrum thin, not effuse.

Dimensions: length 1·3 of an inch, width of body whorl 0·5 an inch.

Position and locality as the preceding.

2. *L. carinata*, n. s. Shell robust, elongated, spire more rapidly tapering than in the preceding species. Whorls 7, slightly rounded, and at their suture bearing a sharp carina extending from the upper angle of the mouth to the extremity of the spire. Mouth twice as long as wide. Columella with a distinct fold.

Dimensions: length 1 inch, width of body whorl 0·4 of an inch.

Position and locality as the preceding.

3. *L. Danvillensis*, n. s. Whorls 7, rapidly diminishing, gently rounded, ornamented with numerous oblique hair-like striæ. Body whorl inflated equal to the spire. Apex minute polished. Pillar lip with a slight fold. Labrum thin and effuse.

Dimensions: length 0·45 of an inch, width of body whorl 0·20 of an inch, width of mouth 0·10 of an inch.

Position and locality as above.

This shell is the shortest of the family which has come under my observation, and for some time it was classed under the Macrocheilus: but after examination of numerous specimens it is placed among the Loxonema.

4. *L. polita*, n. s. Shell slender, elongated. Whorls 6? oblique, slightly rounded, under the glass exhibiting numerous filliform striæ, which converge at the sutures. Apex? (wanting in the specimen). Labium with a slight fold and slightly reflected. Labrum thin and not effuse. Mouth one-half the width of the body whorl.

Dimensions: length 0·5? of an inch, width of body whorl 0·2 of an inch, width of mouth 0·2 of an inch.

Position and locality: roof of Danville coal.

5. *L. nodosa*, n. s. Shell robust, elongated. Whorls numerous, flattened, and exhibiting rudimentary nodes. Mouth and body whorl equal. Pillar lip smooth.

Dimensions: length 1·00? inch, width of body whorl 0·40 of an inch.

Position: in the unproductive shales between the upper and lower coal series of the Appalachian coal measures.

Locality: Summit, Columbiana Co., Ohio.

6. *L. tenui-carinata*. Shell slender, elongated. Whorls 6? very slightly rounded, a hair-like carina at the sutures. Apex? (wanting). Body whorl not inflated. Pillar lip smooth.

Dimensions: length 0·50? of an inch, width of body whorl ·02 of an inch.

Position and locality as above.

7. *L. minuta*, n. s. Shell small, slender. Whorls 6, smooth, gently rounded, body whorl more than one-half the total length of the shell, apex minute, suture well defined, columella smooth and gently curving outwards to meet the labrum. Mouth one-half the length of the body whorl.

Dimensions: length 0·2 of an inch; width of body whorl 0·05 of an inch.

Position and locality: in the roof of Danville coal and upper shales of Sangamon Co., Ill.

Acroculia (Phillips).—1. *A. trigonalis*, n. s. Shell galeated. Whorls scarcely two. Beak incurved, sinistrally inclined. Body whorl rapidly enlarging, inflated. Surface covered by rough imbricated lines of growth, which proceeding from the margin, curve first downwards and then upwards, crossing on the dorsum and giving there almost the appearance of a carina. Mouth subtrigonal.

Dimensions: height 0·7 of an inch, width of body whorl 0·5 of an inch.

Geological position: in a thin band of argillaceous limestone twenty feet below the Danville coal seam.

Locality: Danville, Ill.

2. *A. ovalis*, n. s. Shell galeated. Volutions two and one-half, contiguous, the last whorl greatly inflated. Spire delicate, depressed. Surface smooth, mouth oval.

Height 0·10 of an inch, width of body whorl ·15 of an inch.

In Archimedes beds of mountain limestone.

Union Co., Ill.

NATICA (Lamarck).—*N. Magister*, n. s. Shell very robust, ventricose, short. Whorls 3, the apicial small, body whorl rapidly increasing, inflated, extended below. The suture is well defined. The body whorl exhibits a strong prominent ridge, equal in width to one-fourth of the body whorl. Surface ornamented with coarse striæ which gently curve upon the dorsum, and mounting over the ridge converge at the suture. Pillar lip and umbilicus in the specimen covered with the matrix. Labrum thick. The surface is of cinnamon color and polished.

Height 1·00 inch, width of body whorl 1·20 of an inch.

Locality and position as the preceding. Near Macanda, Ill.

PECTEN (Muhler).—*P. carboniferus*, n. s. Shell sub-orbicular. Hinge-line straight, auricled. Anterior auricle equal to the anterior width of the shell. Posterior auricle wanting in the specimen, what portion is left is rugose. Right valve: beak acute, appressed to the hinge-line, polished. Disk rounded, surface marked by 15 acute ribs, which are ornamented with three series of sharp and more than semicircular scollops, of which the first and more robust series are at the ventral margin, the second is not far removed, the distance of the third and lightest series is from the second double that of the second from the first. Umbone and apex smooth and polished.

Length 0·45 of an inch, height 0·35 of an inch.

Geological position: in the upper shales of the coal measures, at Crooked Creek, Marion Co., Ill.

LEDA (Schumacker).—1. *L. bellistriata*, n. s. Shell twice as long as wide, equivalve, inflated at the umbones. Beaks anterior to the middle of the shell, sharp incurved, appressed, pointing towards the posterior extremity. Margins smooth. Hinge-line curved, armed with twenty-five teeth, about five of them are clustered under the beak, and weaker than their fellows. Escutcheon long, deep and narrow. Surface marked by numerous sharp longitudinal striæ, strong on the disk but fading before they reach the escutcheon and posterior extremity of the shell. Anterior extremity broadly rounded. Posterior produced, attenuated and acutely rounded.

Length 0·7 of an inch, height 0·4 of an inch.

Geological positions: in the roof of the Danville coal, and unproductive shales; Summit, Columbiana Co., Ohio.

2. *L. dens-mamillata*, n. s. Cast twice as long as wide. Beak nearly equal to the anterior of the shell, obtuse, does not touch the hinge-line, surrounded at its base with 7 distinct nodes with corresponding pits—impressions of the pedal muscles. Hinge ornamented with 25 mammillary teeth, slightly elevated and surrounded by a faint ring. Teeth under the beak are feeble, all are posterior. Anterior extremity slightly projecting beyond the beak and truncated. Posterior slightly produced, thin and rounded. Shell inflated at the umbones.

Length 0·9 of an inch, height 0·5 of an inch.

Locality: Battle Creek, Mich.

Geological position: in ochreous shales belonging to the coal measures of Michigan, as is supposed, although found farther west than these are generally thought to extend. It is associated with an Orthoceras, Nautilus and Bellerophon Urii, which is evidently carboniferous, and the following fossils.

3. *L. nuculæformis*, n. s. Shell inflated at the umbones, nearly twice as long as wide. Beak at the anterior third appressed to the hinge-line. Anterior and posterior extremities nearly equally rounded. Posterior slightly produced and attenuated. Hinge-line curved, with 25 teeth posterior and 5 anterior. Under the beak the teeth are feeble and more robust proceeding backwards, the last 10 are large, sharp, and set obliquely to the hinge margin.

Length 1·4 inch, height 0·6 of an inch.

Battle Creek, Mich.

4. *L. pandoræformis*, n. s. Shell (cast) flat but moderately inflated at the umbones. Beaks near the middle of the shell, wide at the umbones. Anterior extremity broadly rounded. Posterior much produced, attenuated and rostrated. In the cast a strong ridge is seen, descending from the beak and curving with the hinge-line, reaches the posterior extremity. Another strong ridge descends from the beak more abruptly to near the ventral margin and then proceeds parallel to the former ridge, until lost in the rostrated extremity, leaving a wide deep fossa between them. Shell exhibits on the surface strong longitudinal lines of growth, arranged in triple series. Cast resembles the Pandora, and hence the specific name. Teeth scarcely visible, probably 10 anterior, 20 posterior, long and slender.

Battle Creek, Michigan.

Nucula (Lamarck).—*N. Houghtoni*, n. s. Shell equivalve, longer than wide. Beaks obtuse, not incurved. Anterior extremity truncate. Posterior acute. Surface smooth. The cast shows pedal muscular impressions at the base of the beak. Posterior adductor muscular impression strong, elevated, semicircu-

lar, situate at the posterior extremity of the hinge-line. Anterior adductor scar fainter and smaller. Hinge-line armed with 9 robust triangular teeth, hollowed at the base and strengthened by strong lateral ridges. Teeth pointing towards the beak, and rising in an arched form from the hinge-line: the inner 3 being 0·1 of an inch high, while the outer are only 0·5 of an inch.

Length 0·7 of an inch; height 0·4 of an inch.

Battle Creek, Mich.

Chonetes (Fischer).—*C. Michiganensis*, n. s. Shell small, inequivalve. Cardinal area formed at the equal expense of both valves. Receiving valve with the disk highly and regularly arched. Hinge-line straight, not equal to the width of the shell. Ears rounded, thin. Ventral margin regularly rounded. Surface ornamented with numerous delicate ridges, which are alternately more robust, arising at the beak, increasing in number as they cross the disk, and on reaching the ventral margin amounting to 80–90, and minutely punctate. Seven slender spines are seen on each side of the beak, on the hinge-line, of which the inner 3 are grouped together and point towards the beak, the outer 3–4 stand progressively farther apart and point more obliquely—the outer stands at right angles to the margin. The outer spine is only to be seen in mature specimens—spines more conspicuous on the casts. Interior of receiving valve is deeply hollowed. A strong septum extends from the beak to the ventral margin. The punctate striæ are more distinct than on the exterior surface. Two conspicuous lateral teeth on each side of the deltidium project inwards and downwards. One arises from the outer the other from the inner edge of the cardinal area.

The cast of this valve exhibits a deep fissure caused by the septum, with the impression of the punctate striæ strongly and regularly impressed upon the margin. Entering valve slightly concave. Hinge-line straight, not equal to the width of the shell. Beak slightly projecting, ornamented with numerous punctate striæ, similar to the opposite valve. Interior exhibits a shallow sinus, beginning at the beak and increasing in width as it approaches the ventral margin, well defined by a sharp ridge on either side, and bearing within it 8–10 filiform punctate striæ. Twenty rows of robust, short, tubular spines on either side, but do not reach the margin by the space of 0·05 of an inch, which space is marked by 80–90 fine, regular striæ. Impressions of tubes and striæ best seen on the cast.

Length 0·5 of an inch; height 0·4 of an inch.

Battle Creek, Mich.

This is one of the most beautiful of the Chonetes family, and is easily distinguished from all other species by the rounded ears, the inward direction of the spines, and the mesial depression to be seen only on the interior of the entering valve.

Chiton (Linnæus).—1. *C. carbonarius*, n. s. Anterior valve semicircular, broadly rounded in front, arched. Middle valve subquadrate, elevated into a well defined ridge on the dorsum ending posteriorly in an acute apex and overlapping the succeeding valve. Posterior valve rounded behind, the margin strengthened by an elevated carina of a horse-shoe shape and extending in front two-thirds of the length of the valve. The dorsum is elevated, somewhat conical, a ridge extending from the anterior edge to the middle and ending in an acute apex. From the apex the valve slopes regularly to the margin. The last seven valves have on either side of the ridge and projecting anteriorly from the lateral areas an accessory plate, which when detached is smooth, thin posteriorly, wide and round in front, where it is attached to the preceding valve. The surface of all of the valves is ornamented with fine granulations arranged in rows parallel to the margin, causing the suspicion that the living animal was spinous or hispid.

Plates, length 0·5—0·8 of an inch; shell 4—6 inches.

Modern Chitons, as is well known, have apophyses on the front, lateral margins which strengthen the attachment of the valves. The *C. carbonarius* has accessory plates which are firmly attached (anchylosed?) to the posterior plates by their acute extremities, but loosely attached by their rounded extremities to the anterior valves.

In the roof of the Danville coal.

2. *C. parvus*, n. s. Anterior valve semicircular conical. Apex pointing posteriorly, sloping regularly to the margin. Middle valves acutely subrhomboidal, scooped in front, sharp behind, dorsum elevated, terminating posteriorly in an acute apex. Posterior valve semicircular behind, abrupt in front, rising into an acute ridge, extending to the middle of the valve, terminating in an acute apex, from which the valve slopes to the margin, which is thickened and turned up. Accessory plates more broadly rounded than in the preceding species. Surface under the glass, is minutely granulated.

Length: plates, 0·1 of an inch: shell 1–2 inches.

Archimides limestone, Bergen Hill, Ind.

Appendix.

Avicula (Klein).—1. *A. orbiculus*, n. s. Shell circular, flattened, thin, attenuated at the margins. Hinge-line straight, one half the width of the shell. Auricles small, corrugated, beak small, scarcely prominent, surface smooth.

Dimensions: height 0·75 of an inch. Width, ditto.

Position: in the calcareous shales, between the upper and lower coal series of the Appalachian system, at Summit, Columbiana Co., Ohio. In the upper black shales at Springfield, Ill.

2. *A. triplistriata*, n. s. Shell small, inequilateral, hinge-line straight, and sloping posteriorly. Anterior auricle the largest, bordered by an elevated ridge, umbones moderate, beaks hidden. Anterior portion of the surface ornamented with 30 crenulated striæ for the most part arranged in triple series. The posterior portion has 12 crenulated striæ, which are stronger than those of the anterior portion.

Dimensions: height 0·5 of an inch; width, ditto.

Position and locality: in calcareous shales at Summit Station, Columbiana Co., Ohio.

POSIDONOMYA (Bronn).—*P. striata*, n. s. Shell small, subdiscoidal. Hinge-line straight, nearly equal to the width of the shell. Beak? obscure, surface ornamented with 15 strong striæ, which proceeding from the hinge-line, become dichotomous before reaching the cardinal margin, and are crossed by numerous concentrical lines parallel to the margin.

Dimensions: height, 0·4 of an inch; width, ditto.

Position and locality same as the preceding.

GERVILLA (Defrance).—*G. Auricula*, n. s. Shell elongated, inflated, almost cylindrical, apex appressed to the hinge-line, near the anterior extremity which is rounded and earless. Posterior extremity prolonged, curved, acute; posterior ear winged, reaching one half the width of the shell; hinge-line straight. Surface smooth, save at the anterior extremity, where a few incremental lines are visible.

Dimensions: length, 0·75 of an inch; height 0·20; length of hinge-line with ear, 0·45 of an inch.

Position and locality: in the roof of Danville coal, Danville, Ill.

North Egremont, Mass., Dec. 10, 1857.

SCIENTIFIC INTELLIGENCE.

I. CHEMISTRY AND PHYSICS.

1. *Researches on indices of refraction.*—JAMIN has undertaken to determine the refracting power of water when compressed or when reduced to vapor. The experiments were executed by means of the author's very beautiful apparatus for interferences described in the 42d volume of the Comptes Rendus. The water examined was enclosed in two parallel tubes one of which was open while the other was subject to variable pressure. At every change of pressure the fringes underwent a displacement which was measured and from which the variations in the refracting power of the liquid could be calculated. To avoid the error arising from the increase in the length of the compressed column, the two tubes were plunged into a trough full of water, so that the interfering rays traversed the length of the tubes and the spaces separating their extremities from

the sides of the trough. If one of the tubes changes its length by a small quantity, the external space diminishes by the same quantity and thus the effect of the dilatation is sensibly destroyed. The author finds that with this apparatus one millimetre of pressure, more or less, produces an interval of $\frac{1}{100}$ of a fringe which is easily observed: for an entire atmosphere there is a displacement of 28 fringes. The sensibility of the apparatus could be still more increased by giving the tubes a greater length than that of one meter which was employed. The author found that in all his experiments, the difference of path produced by pressure was sensibly proportional to the pressure, so that if we calculate the compressibility of water from the optical experiments, we find the coefficient to be 0·0000500 for common distilled water and 0·0000511 for water deprived of air. According to the direct measures of Grassi this coefficient is 0·0000504. Jamin has also measured with the same instrument the index of refraction for the vapor of water. Two tubes were employed 4 meters in length: one of these was filled with perfectly dry air; the other with air charged with a known proportion of the vapor of water. The difference in the refractive powers could then be observed by the change produced in the fringes. There was generally a difference of 8 fringes between dry and saturated air. More than fifty measurements made under very different circumstances of temperature, pressure, and hygrometric condition, agreed in assigning to the refractive power of vapor at 0° and 760^{mm} the value 0·000521. The author finds farther that the diminution in the index of refraction of air by saturation with vapor would only affect the seventh decimal of the number 1·000292 . . . found for that index, and that consequently in astronomical refractions it is useless to trouble oneself about the vapor of water.—*Comptes Rendus*, xlv, 892.

2. *On the density of the vapors of certain bodies.*—Deville and Troost have communicated to the Academy of Sciences a memoir on the densities of the vapors of certain chlorids which possesses great interest. The authors employed in their experiments a new and ingenious method which appears in point of accuracy and convenience to leave little to be desired. The principle of this method consists in plunging the balloon containing the substance into the vapor of some other substance which boils at a high temperature without decomposition. In this manner no thermometer is necessary. The authors employ for this purpose sulphur and mercury, the former boiling according to Dumas at 440° C., and the latter at 350°. The apparatus used consists of a mercury bottle cut off near the neck so as to form a cylinder closed at the bottom. In the interior there are two diaphragms pierced with holes, which serve to hold the balloon at a height of 6 or 8 centimetres above the bottom of the bottle. To cut off the furnace heat from the vapor cylindrical laminæ are placed parallel to the sides of the bottle. The upper part is closed by means of a plate of cast-iron provided with two holes, through one of which passes the narrow neck of the balloon, and through the other the stem of an air thermometer which need not be graduated and which serves only to indicate the constancy of the temperature. The authors subsequently omitted the thermometer as unnecessary. An iron tube is attached to the upper part of the bottle to carry off the vapor of the mercury or sulphur for condensation; one kilogram of sulphur and one or two kilo-

grams of mercury are usually employed. In this manner the following densities were determined. Sesquichlorid of aluminum in the vapor of mercury 9·35; in the vapor of sulphur 9·34: the calculated density (Al_2Cl_3=2 vols.) is 9·31. The density of sesquichlorid of iron was found to be 11·39; the calculated density (Fe_2Cl_3=2 vols.) is 11·25. Protochlorid of mercury gave a density of 8·21=4 vols.: Mitscherlich found 8·35. The density of the sesquichlorid of zirconium was found to be 8·15 which leads to the formula $ZrCl_3$=2 vols. for this chlorid. The authors propose to employ the vapor of zinc instead of that of sulphur or of mercury, and to use porcelain balloons which can be sealed up by the oxhydrogen blowpipe. Chemists will anxiously await the result of these experiments which promise to be of great theoretic value.—*Comptes Rendus*, xlv, 821.

3. *Memoir on the equivalents of the elements.*—Dumas has presented to the Academy of Sciences a very interesting paper upon the equivalents of the elements which not merely contains several re-determinations of the equivalents themselves, but points out remarkable numerical relations between the atomic weights of bodies belonging to the same natural group. The author gives the following as the results of his numerical determinations:

Silver, 108	Fluorine, 19	Tungsten, 92
Chlorine, 35·5	Selenium, 40	Manganese, 26
Bromine, 80	Tin, 59	Boron, 11
Iodine, 127	Molybdenum, 48	Silicon, 21.
Sulphur, 16		

The equivalent of silver was calculated from Marignac's analyses by taking nitrogen = 14 and oxygen = 8. To determine the exact number for chlorine the author heated weighed quantities of silver in a current of chlorine gas, maintaining the temperature until the resulting chlorid was completely fused. This very beautiful method requires but three weighings and leads precisely to the number 35·5. The equivalents of bromine and iodine were determined by heating weighed quantities of bromid and iodid of silver in a current of chlorine and fusing the resulting chlorid. These numbers agree with those found by Marignac. The equivalent of fluorine was determined by the analysis of a very pure native fluor spar as well as by that of crystallized fluorids of sodium and potassium. The number 16 for sulphur was verified by burning a known weight of silver in a current of the vapor of sulphur. Direct experiments on the formation of chlorid of selenium gave the number 40 for the equivalent of that element: the author thinks that the difference between his result and that of Berzelius is due to the fact that he was able to employ a purer selenium. The equivalent of tin was found by the method of Berzelius, that is to say, by heating the bichlorid with nitric acid and igniting the resulting stannic acid. The acid ignited in a mattrass of hard glass gave precisely the equivalent found by Berzelius, viz., 58·8, but on ignition in a platinum crucible the oxyd loses traces of water, and after this correction the equivalent becomes 59. The equivalent of molybdenum was determined by igniting molybdic acid in a current of hydrogen and was found to be 48. [This result differs by two entire units from that of Svanberg and Struve who found 45·92, and from that of Berlin who found 45·98.—W. G.] The equivalent of tungsten was

determined in a similar manner. [The author's result in this case agrees with those of Schneider and Marchand.] In the case of manganese the number 26 was found by igniting an artificial binoxyd in a current of hydrogen so as to reduce it to protoxyd. [Dumas' equivalent for manganese differs so greatly from that of Berzelius, 27·6, as to make farther researches desirable.—w. g.] The number 11 for boron is calculated from recent analyses of the chlorid by Deville: that of silicon was determined by analyses of the chlorid and found to be between 21 and 21·2. The author found it however impossible to remove from the chlorid traces of chloroxycarbonic acid which it holds in solution, and the presence of which is easily shown by agitating the chlorid with water when carbonic acid gas is disengaged.

The author is still engaged with the subject of a revision of the equivalents and the publication of his results—which cannot be looked for till the close of the present year (1858)—will be awaited by chemists with special interest.

In order to exhibit the numerical relations between the equivalents of the different elements the author, after referring to the previous investigations of Prof. Cooke, takes up in the first place the examination of certain groups and series presented by organic chemistry. If we consider the homologous series C_2H_2, C_4H_5, C_6H_7, &c., we remark at once that there is a common point of departure for and a common difference between the equivalents of the successive terms. The formula $a+nd$ represents the generation of all these radicals, a being the equivalent of the first, and d the difference between the first and second term. The author remarks that if we did not know the law of progression we might easily be led to think that the ratio between the numbers 141 and 281, 127 and 253, 113 and 225, is the simple ratio of 1 : 2, especially as chemistry can hardly decide with absolute certainty whether an element has, for example, the equivalent 225 or 226. The formula deduced from the simple progression above mentioned would not account for the generation of the elements as Prof. Cooke supposed. But the organic radicals are not always produced by addition but sometimes by substitution as we see in the compound ammoniums. We may have for instance the following ammoniums:

a	$a+d$	$a+2d$	$a+3d$	$a+4d$
	$a+d'$	$a+d+d'$	$a+2d+d'$	$a+3d+d'$
		$a+2d'$	$a+d+2d'$	$a+2d+2d'$
			$a+3d'$	$a+d+3d'$

$$a+d+d'+d''+d''',$$

where a represents ammonia NH_4, and d, d', &c. represent the equivalent of hydrocarbons of the series CnHn.

In the next place there are certain radicals in organic chemistry where the fundamental molecule itself changes as well as the bodies added to or substituted in it. Thus tin and ethyl form six molecular groups possessing all the properties of organic radicals. If we represent tin by a and ethyl by d' we have for the six species of stannethyl the formulas

$a+d'$	$2a+d'$	$4a+d'$
	$2a+3d'$	$4a+3d'$
		$4a+5d'$

($na+nd'$) being the general formula. With these premises the author proceeds to compare the equivalents of the elements. The elements F, Cl, Br, I, do not form a single progression. The relation between their equivalents is however exhibited by the scheme a, $a+d$, $a+2d+d'$, $2a+2d+2d'$, or in numbers,

Fluorine,	19
Chlorine,	19+16·5=35·5
Bromine,	19+33+28=80
Iodine,	38+33+56=127.

Nitrogen, phosphorus, arsenic, antimony and bismuth form another natural group, and for their equivalents we have the scheme, a, $a+d$, $a+d+d'$, $a+d+2d'$, and $a+d+4d'$, or in numbers,

Nitrogen,	14
Phosphorus,	14+17=31
Arsenic,	14+17+44=75
Antimony,	14+17+88=119
Bismuth,	14+17+176=207.

The author gives similar series for carbon, boron, silicon, and zirconium, as well as for tin, titanium and tantalum, which we omit. For oxygen, sulphur, selenium, and tellurium we have either of the series a, $2a$, $5a$, $8a$, or a, $a+d$, $a+4d$, $a+7d$. Analogy points out the latter as preferable, and we have in numbers,

Oxygen,	8
Sulphur,	8+8=16
Selenium,	8+32=40
Tellurium,	8+56=64.

A common difference of 8 also connects Mg, Ca, Si, Ba, Pb; thus we have

Magnesium,	12
Calcium,	12+8=20
Strontium,	12+32=44
Barium,	12+56=68
Lead,	24+80=104.

Lithium, sodium and potassium belong to a similar series with a common difference of 16.

Lithium,	7
Sodium,	7+16=23
Potassium,	7+32=39.

Molybdenum, tungsten, chromium, and vanadium form a similar series of which the common difference is 22, the progression being 26, 48, 70, 92. The author considers his results as favorable to the idea of Dr. Prout, who supposed the equivalents of all the elements multiples by a whole number of that of hydrogen. In the case, however, of chlorine and perhaps of some other elements the unit of reference is less than the equivalent of hydrogen and is probably 0·5. In all the series the first member determines the chemical character of all the other terms. These considerations, the author remarks, will have more weight when he presents the study of a natural family of which hydrogen is the first term, and

exhibits the connection between the physical properties of the elements and the position which each occupies in the series of which it forms a member.—*Comptes Rendus*, xlv, 709, *Nov.*, 1857.

4. *On new compounds of silicon.*—Buff and Wöhler have continued their investigation of the compounds of silicon with chlorine, &c., and have arrived at many interesting results. When crystalline silicon is heated below redness in a current of chlorhydric acid, a volatile liquid is formed which appears to be a mixture of various compounds. On distillation this liquid usually begins to boil at 28° or 30° C.; the temperature rises, however, rapidly to 40°–43°, when the greater portion of the liquid passes over. The boiling point finally rises to over 60°, and in one case even to 92°.

The new chlorid is a colorless mobile liquid of a penetrating smell, fuming strongly in the air and covering everything around with a white deposit. Its boiling point is 42° C. and its density 1·65: these numbers however are only approximately accurate. The liquid is a non-conductor of electricity; its vapor is as inflammable as that of ether, and it burns with a faintly luminous greenish flame, giving off silica and chlorhydric acid. The vapor of the chlorid explodes with oxygen very violently: the residual gas is fuming and consists of the ordinary chlorid and chlorhydric acid, so that half the silicon is oxydized to silicic acid. When the vapor of the new chlorid is conducted through a narrow glass tube heated to redness, it is very easily decomposed, giving a brown film of amorphous silicon. Fused aluminum also decomposed the chlorid with great ease, hydrogen being set free, chlorid of aluminum formed and silicon deposited. Water decomposes the chlorid immediately into muriatic acid and a white oxyd which differs greatly from silica in not being gelatinous. The author's analyses lead directly to the formula $Si_2Cl_3 + 2HCl$, so that the new substance is not properly a chlorid of silicon as at first supposed.

A corresponding bromine compound may be prepared in a precisely similar manner, and is a colorless fuming liquid. The iodine compound $Si_2I_3 + 2HI$ is a dark red brittle mass which fumes in the air, becoming at first cinnabar-red and finally snow-white. It melts easily and becomes crystalline on cooling; it may be distilled without decomposition. Bisulphid of carbon dissolves it in large quantity with a blood-red color; from this solution it crystallizes on concentration.

The hydrated sesquioxyd $Si_2O_3 + 2HO$ is a snow-white amorphous body: it is very light and voluminous and floats upon water. Alkalies and their carbonates, and even ammonia, dissolve it with strong effervescence of escaping hydrogen to silicates. Acids in general exert no action, but fluohydric acid dissolves it with evolution of hydrogen. The hydrate may be heated to 300° without losing its water or otherwise changing. When more strongly heated, it ignites and glows with a phosphorescent light, while hydrogen is given off and burns with explosion.

When heated in oxygen it burns brilliantly. When heated in a tube it gives off a gas which fumes in the air but does not inflame, and which appears to be a mixture of spontaneously inflammable siliciuret of hydrogen and hydrogen. The hydrate is slightly soluble in water and is a powerful reducing agent, reducing selenious and tellurous and even sul-

phurous and hypermanganic acids. The authors have made several observations which render it probable that there is a lower chlorid than that already described, and consequently also a lower oxyd. In one case an oxyd was obtained which appeared to have the formula SiO_4+3HO. When amorphous silicon is used instead of the crystalline in the preparation of the chlorid scarcely any liquid chlorid is obtained, but only a gas which on condensation in water gives an oxyd containing 52·75 per cent of silicon, and which burned more brilliantly than any other. This percentage is nearly 2 p. c. higher than that in the hydrated sesquioxyd. The authors further remarked in one case the existence of a chlorid which when mixed with air exploded on gentle heating. Chemists will wait the final results of this important investigation with especial interest. —*Ann. der Chemie und Pharmacie*, civ, 94.

5. *New Researches on Boron.*—Wöhler and Deville have communicated to the Academy many additional facts of interest in relation to the chemical history of boron. To obtain amorphous boron the authors mix 100 grams of fused and coarsely powdered boric acid with 60 grams of sodium and project the mixture into a red-hot cast-iron crucible. The whole is then covered with 40 or 50 grams of fused common salt and the crucible closed. After the reaction, the fused mass is stirred with an iron rod, and the fused mass poured into water acidulated with chlorhydric acid and contained in a deep vessel. On filtering, the boron remains on the filter and is to be washed first with acidulated and then with pure water. The boron may now be dried upon a brick at ordinary temperature, as it might otherwise take fire and burn rapidly. Amorphous boron may be transformed into crystalline boron by lining a crucible with it and putting in a piece of aluminum. At a high temperature the aluminum becomes charged with boron from which it is easily separated by acids. In this experiment the boron which has not undergone the transformation is found to have become white, and to have absorbed nitrogen which has passed through the walls of the crucible. Boron heated in a current of ammonia appeared to take fire, nitruret of boron being formed while hydrogen is set free. This nitruret when treated with caustic potash disengages torrents of ammonia. Boron heated in a current of nitrogen forms the same white infusible compound, and a similar result is obtained when a mixture of charcoal and boric acid is heated in a current of nitrogen or of ammonia. From all this it appears that it is impossible to heat boron in ordinary crucibles or furnaces without the formation of a nitruret. The only mode of overcoming the difficulty consists in surrounding the crucible containing the boron with a mixture of rutile and carbon, in which case the nitrogen is absorbed by the free titanium.

At a red heat amorphous boron decomposes the vapor of water, boric acid and hydrogen being formed. Sulphid of hydrogen is also decomposed by boron with disengagement of hydrogen and formation of a sulphid. Chlorhydric and bromhydric acids are decomposed under the same circumstances. The chlorid thus formed is that already well known, but this and the bromid are not gases, as heretofore supposed, but volatile liquids, the chlorid boiling at 17° C., and the bromid at 90° C. Their vapor-densities correspond to 4 volumes. There is also an oxychlorid, an oxybromid, an oxyiodid and an oxyfluorid, which however are not described in the notice before us.

Amorphous boron reduces the chlorids of mercury, lead, and silver, at a high temperature with production of chlorid of boron. Galena is reduced in a similar manner, metallic lead being set free and a sulphid of boron formed. In conclusion the authors direct attention to the fact that nitrogen, hitherto considered a passive and inert substance, may under certain circumstances become an active agent. They announce the discovery of a simple mode of preparing the nitruret of silicon which will form the subject of another memoir.—*Comptes Rendus*, xlv, 888. W. G.

6. *On the Magnetic Induction of Crystals;* by Professor JULIUS PLÜCKER of Bonn, For. Memb. R. S., Hon. M.R.I., &c. (Proc. Roy. Soc. in Phil. Mag., vol. xiv, p. 477).—The author commences by referring to his discovery of the peculiar action of magnets on crystalline bodies, and to the researches to which he was thereby led. With reference to the form in which he enunciated the law regulating the action of a magnet on a uniaxal crystal—that the optic axis is attracted or repelled by the poles of the magnet—he disclaims any intention of assigning a physical cause to the phenomenon, or doing anything more than expressing the results of observation, which are *as if* such a force existed. In the case of crystals of a more complicated character, he was led, in the first instance, to assume the existence of two magnetic axes, possessing a similar character as to attraction and repulsion with the one axis of optically uniaxal crystals. But finding that the proposed law did not hold when the crystal was examined in all directions, and not solely along peculiar axes, he abandoned, nearly two years ago, a hypothesis respecting which serious doubts had arisen long before. For the hypothesis of one or two axes acted upon by the magnet, he substituted another similar hypothesis. In the case of uniaxal crystals he now conceived an ellipsoid of revolution, consisting of an amorphous paramagnetic or diamagnetic substance, and having within the crystal its principal axis coincident with the principal crystallographic axis. It is easy to verify that both crystal and ellipsoid, the poles of the magnet not being too near each other, will be directed between them in exactly the same way. In the generalization, an ellipsoid with three unequal axes, having a determinate direction in the crystal, must be substituted for the ellipsoid of revolution. In this hypothesis too, two "magnetic axes" are met with, that is, according to the new definition, directions which possess, in common with the single crystallographic axis of uniaxal crystals, the property that if the crystal be suspended so that either of these axes is vertical, and the body is at liberty to turn freely round it, no extraordinary magnetic action is exhibited, but the crystal behaves like an amorphous substance.

According to observation, a crystal under favorable circumstances is directed in the same way as the smallest of its fragments. Hence, according to the new hypothesis, each of its particles may be regarded as acted on like an amorphous ellipsoid. But such an amorphous molecular ellipsoid, when influenced by a magnetic pole at a finite distance, will be directed like an ellipsoid of finite dimensions under the influence of an infinitely distant pole. Here Poisson's theory presented itself for the verification of the hypothetical conclusions and their consequences, to which the author had been led by considerations of a different kind. This verification had the most complete success. But before proceeding to it, it was found necessary to confirm Poisson's theory itself (or rather

the results following from it), with respect to an ellipsoid of finite dimensions influenced by an infinitely distant pole. By means of a beautiful theorem lately published by Professor Beer, by which the results relating to the influenced ellipsoid are simply and elegantly expressed by means of an auxiliary ellipsoid, the author was enabled to deduce immediately the analytical expressions. These were afterwards compared with experiment, by observations made on two carefully worked ellipsoids of soft iron, executed by M. Fessel of Cologne.

The results thus obtained from theory, and verified by experiment, with reference to an amorphous ellipsoid, were compared with the results obtained from the observation of crystals, and manifested a complete agreement. According to this theory, the magnetic induction within a crystal is, like the elasticity of the luminiferous ether, determined by means of an auxiliary ellipsoid. As there are three rectangular axes of optical elasticity, so there are three principal axes of magnetic induction, characterized by the property that if a crystal be suspended along any one of them, the two others set, one axially, and the other equatorially. As there are two optic axes, situated in the plane of the axes of greatest and least elasticity, so there are two magnetic axes, characterized by the property already mentioned.

Among crystals, the author selected for special examination red ferrocyanid of iron, sulphate of zinc, and formiate of copper. The first is paramagnetic, the second diamagnetic, and in both cases the principal axes of magnetic induction are determined by the planes of crystalline symmetry. The setting of elongated prisms, as well as of long cylinders and short cylinders or circular plates, cut in various selected directions from the crystals, is described in detail. The use of both cylinders and circular plates, cut with their axes in the same direction, obviated any objection which might be raised attributing the setting to the external form, since, so far as was due to mere form, a cylinder and a circular plate would set with their axes in rectangular directions.

Formiate of copper differs from the former crystals in having but one plane of crystalline symmetry, and accordingly in having but one principal axis of magnetic induction determined by the crystalline form. The existence of three principal magnetic axes, having the property already mentioned, was demonstrated experimentally, and the directions of those two which were not determined by the crystalline form, were ascertained by experiment. In this crystal the axes of greatest and least induction, and consequently the magnetic axes, lie in the plane of symmetry; and the existence of two magnetic axes was demonstrated, and their positions were determined.

In conclusion, the author gives a list of crystals, classified according to their paramagnetic or diamagnetic characters, and the order of magnitude of the magnetic inductions in the direction of their principal axes. He also remarks that some crystals, of which instances are given, though belonging according to their form to the biaxal class, have two of their principal magnetic inductions so nearly equal that they cannot be distinguished from magnetically uniaxal crystals; while others, though not belonging to the tesseral system, have all their principal inductions so nearly equal that they cannot be distinguished from amorphous substances.

II. GEOLOGY.

1. *Quarterly Journal of the Geological Society*, No. 52.—The most important memoir in this number is one by Dr. Falconer *on the Species of Mastodon occurring fossil in Great Britain*, which is to be followed by another on the species of Elephant. The author reviews the generic distinctions and nomenclature of the Proboscidea in general, and then enters upon the fossil Mastodon of Great Britain. The number of existing species of Proboscideans is but two, while of extinct species thirteen are enumerated. Dr. Falconer subdivides both the genera, Elephas and Mastodon, according to the teeth, remarking, at the same time, that the two groups graduate into one another in the forms of these parts. The two subgenera of Mastodon are *Trilophodon* and *Tetralophodon*, the first having *three* ridges to the intermediate molars, the latter *four*. The subgenera of Elephas are *Stegodon* (approaching the Mastodons most closely), *Loxodon* and *Euelephas*. Of the extinct species, the Miocene has afforded *Trilophodon tapiroides* (Europe), *T. angustidens* (in "immense abundance" in France, Germany, Switzerland), *T. pyrenaicus* (Europe); *Tetralophodon longirostris* (Europe), *Tet. latidens* (Southern India), *Tet. Perimensis* (Southern and Western India), *Tet. Sivalensis* (India); *Stegodon Cliftii* (= Mastodon latidens of Clift in part, Southern India, Ava), *S. bombifrons* (India and Sewalik Hills), *S.? Ganesa* (ibid), *S. insignis* (ibid); *Loxodon planifrons* (ibid); *Euelephas Hysudricus* (ibid). In the Pliocene have been found, the *Trilophodon Borsoni* (Europe, Southern India); *Tetralophodon Arvernensis* (England and Europe); *Stegodon insignis* (see above), *Loxodon meridionalis* (England and Europe), *L. priscus* (England and Lombardy); *Euelephas antiquus* (England and Europe), *E. Namadicus* (Central India). Probably of the Pliocene, are the *Trilophodon Pandionis* (Southern India), and the *Tetrolophodon Andium*. To the Postpliocene belong, *Trilophodon Ohioticus*, Blumb. (= Mastodon giganteus, North America), *Euelephas primigenius* (Europe, Asia and North America). The *Trilophodon Humboldtii* (South America), and *Euelephas Columbi* of Mexico, Georgia and Alabama, (to which *E. Jacksoni*, described in Amer. J. Sci., 1838, xxxiv, 363, is referred with a query,) are regarded as probably Postpliocene.

The British species of Mastodon is the *Tetralophodon Arvernensis*. It occurs in what is called the Older Pliocene "Red Crag," at Felixstow and Sutton in Suffolk, and in the Newer Pliocene "Fluvio-marine" or "Mammaliferous Crag" in various localities near Norwich in Suffolk, and is associated with the remains of the Elephant, *Loxodon meridionalis*. Dr. Falconer discusses the age of these deposits and concludes that they are alike pliocene, and agree with the great pliocene Fauna of Italy as exhibited along the valleys of the Po and Arno. The mixed contents of the Red Crag, including Mammalian remains of different strata from the Eocene period upwards (which have led to the suspicion of an earlier age) are inferred to have been deposited in the reconstructed strata, also within the Pliocene period. "The Red Crag sea appears to have breached a previously established and populated Pliocene land, and to have buried the bones referable to various epochs in the same sea bottom."

This paper by Dr. Falconer is preceded by the able anniversary address of the President Colonel J. E. Portlock—a review of various geological papers published during the year preceding, and occupying 123 pages. Following it, there is an article by Prof. T. H. Huxley, on a new Crustacean of the Lias bone-bed at Aust Passage, which is macroural or anomoural, probably the latter, and is named *Tropifer lævis*. Also another species from the Coal Measures at Medlock Park Bridge, named *Pygocephalus Cooperi*, which he regards as related to the Squillidæ.

2. *Annual Report of the Geological Survey of the State of Wisconsin*, for the year ending Dec. 31, 1857; by Edward Daniels, Geologist. 62 pp., 8vo. Madison, 1858.—This Annual Report by Mr. Daniels, for 1857, treats briefly of some Iron Ores of Wisconsin. 1st. The red argillaceous or "seed ore" of Dodge County, which is believed to belong to the same age as the Clinton group, like the similar ore of Central New York. The bed is generally ten to fifteen feet thick; it lies between a massive grey limestone above, equivalent to the Niagara and Clinton groups and a soft blue shale of the age of the Hudson river group. An analysis of the ore by Dr. C. T. Jackson afforded peroxyd of iron 72·50, lime 0·56, oxyd of manganese 1·40, alumina 8·40, magnesia 0·64, silica 7·75, water 8·75 = 100. The same kind of ore occurs also at Hartford, Washington Co., fourteen miles southeast of Iron Ridge, where the bed is six to seven feet thick; and in the town of Depere, eighty miles north-northeast of Iron Ridge, six and a half feet thick.

2nd. Magnetic and specular iron ores, in Azoic or crystallized rocks. They occur at Black River Falls, in chloritic and micaceous schists, over which in some parts of the region the Potsdam sandstone occurs, resting nearly or quite horizontally on the upturned edges of these schists. The ore is conformable to the lamination of the schists and is sometimes banded with quartz; the beds are six to forty feet wide, occurring in several alternations, and are inexhaustible. They are related in character to those of the Lake Superior region described by Foster and Whitney, and also to those of Northern New York.

3d. Specular and titaniferous ores occur in Baraboo valley in quartzite which is the hardened Potsdam sandstone. It is laminated, slightly waving, and has a high lustre; it is slightly magnetic. The ore is not abundant.

4th. At Ironton, in the town of Marston, Sauk County, hydrated oxyd of iron (limonite) occurs in the Potsdam sandstone. The bed averages five feet in thickness.

3. *On the Newer Pliocene and Post-pliocene deposits of the vicinity of Montreal;* by J. W. Dawson, LL.D., Principal of McGill College, (Canadian Naturalist and Geologist, ii, 401.)—Mr. Dawson has added much by his labors to our knowledge of the Post-pliocene deposits of the St. Lawrence valley about Montreal. In his paper, he reviews the facts before known and gives descriptions of some new fossils and their localities, together with general remarks on the region. We cite some of the statements.

The mountain back of Montreal has strongly marked sea-margins at heights of 470, 440, 386, and 220 feet above Lake St. Peter on the St. Lawrence (or 450, 420, 366, and 200 above the river at Montreal). The highest contains sea shells of existing species.

One hundred feet below the lowest spreads the plain of Lower Canada, containing abundant marine shells, all of them, with one or two exceptions if any, recent. It consists (1.) of a sand deposit, sometimes gravelly beneath, and containing marine shells in its lower part; (2.) an unctuous calcareous clay, with some marine shells; (3.) compact boulder clay, filled with stones of the crystalline rocks, usually partially round and often scratched and polished.

The trap boulders derived from the Montreal mountain, as Dr. Bigsby early pointed out, were drifted southwest, and have been traced 270 miles to the south shore of Lake Ontario. But the terraces are most distinct on the northeast side. Under the boulder clay the surfaces are striated, and northeast of Montreal mountain, the directions observed were S. 70° W., to S. 50° W.

The deposits of the plain appear to be in part at least of littoral or shallow water origin. This is indicated for the upper layer, near the Tanneries, by the great numbers of *Saxicava rugosa*. But the clay below abounds in *Nucula* (*Leda*) *Portlandica*, which probably lived in muddy bottoms 10 to 15 fathoms in depth. The same arrangement is observed at other localities. Mr. Dawson names the upper layer the *Saxicava sand*, the lower the *Leda clay*.

From the Leda clay near St. Denis, at the cutting of the Montreal and Ottawa railway, Sir W. E. Logan has obtained a number of caudal vertebræ of a Cetacean, part of the pelvis of a seal, and fragments of wood of the cedar (Thuja occidentalis). At one locality, the following species were obtained from the upper layer: (we indicate below by an asterisk the species not before reported as Canadian:) *Tellina Groenlandica, Saxicava rugosa, Mya arenaria, Mytilus edulis, Astarte Laurentiana, Tellina calcarea, Trichotropis borealis, Fusus borealis, Fusus tornatus,* Bulla Oryza,* Leda Portlandica.* At another, near the house of James Logan, Esq., "an intermediate deposit," the above occur along with *Balanus crenatus* (*B. miser* of some lists), *Mya truncata, Spirorbis sinistrorsa** (on stones and valves of Mya truncata), *Natica clausa, Buccinum ciliatum,* B. undatum, Admete viridula,* Acmæa cæca,* Nucula minuta, Lacuna neritoides,* Natica helicoides?* Fusus scalariformis,* Serpula vermicularis,* Margarita arctica,* Modiolaria discors, Rissoa minuta,* Bulla debilis?* Trichotropis arctica,* Cytheridea Mulleri?* Velutina zonata?* besides several species of Foraminifera,* masses of siliceous spicula of a sponge (Tethæa*). From the associated shells it appears that the celebrated locality of the Capelin (*Mallotus villosus*) and Lump-sucker (*Cyclopterus Lumpus*), at Green's Creek on the Ottowa belongs to this level, its elevation being 118 feet above Lake St. Peter; it has afforded also small specimens of *Leda pygmæa;* remains of probably an Ophiura-like Starfish;* also of the plants *Populus balsamifera** and *Potentilla Norvegica** with Algæ.* *Fusus harpularius, Menestho* (Chemnitzia) *albula, Amicula vestita* (Chiton Emersonii of Gould), and *Leda minuta*, are other reported species of the Canada post-tertiary.

The locality at Beauport near Quebec, described by Captain Bayfield and Sir C. Lyell, belong to this same level, and has afforded, besides others already named, the following not enumerated above: *Balanus Hameri, Natica Groenlandica,* Natica Heros,* Turritella erosa,* Scala-*

ria Groenlandica, Littorina palliata, Cardium Groenlandicum, Cardium Islandicum, Pecten Islandicus, Rhynconella psittacea, Echinus granulatus.

A locality at St. Nicholas, fifteen miles above Quebec, on the south side of the St. Lawrence at an elevation of 180 feet, 400 yards from the river, has afforded *Tellina calcarea* (most abundant and large), *Balanus Hameri* (abundant), *Mya truncata, Saxicava rugosa, Astarte Laurentiana, Trichotropis borealis* and *Buccinum undatum.* The bed—of hardened clay—was probably formed in deep water.

At the terraces of 220 and 386 feet on Montreal mountain no shells have been found. But westward of Montreal, near Kemptville, Sir W. E. Logan has found littoral shells at 250 feet above Lake St. Peter. Another locality in Winchester is 300 feet; another in Kenyon 270 feet; two others in Lochiel 264 and 290 feet; at Hobbes Falls, Fitzroy, at 350 feet; at Dulham Mills on the De L'Isle, at 289 feet above the St. Lawrence; on the Portland and St. Lawrence railroad, near Upton Station, at 257 feet; still farther east, on the river Gouffre, near Murray Bay, at 130 and 360 feet above high tide.

The terrace of 470 feet, the highest observed, consists of (1) 8 feet of angular stones and sand; (2) fine gravel with shells principally Saxicava rugosa, 5½ feet; (3) 6 feet of stratified sand with few shells. On the Ottawa, in the 4th concession of Nepean, Logan has found a similar beach at 410 feet. "On the west, the highest terrace observed by the U. S. Geologists on the south side of Lake Ontario, appears to correspond with this sea level, and the gravel and sands containing elephantine remains near Hamilton, may have been washed into its western extremity from the neighboring land." Marine shells have not yet been found west of Kingston.

Among the shells, *Leda Portlandica* and *Astarte Laurentiana* belong to the Leda clay, and are suspected to be extinct, the first, if recent, is stated to be the *L. truncata*, and the other the *A. sulcata.* All the deposits overlie the inferior or "unmodified drift."

This valuable paper is accompanied by two plates, containing figures of several of the species noticed.

4. *Crinoids of New York.*—We have received some sheets of Prof. James Hall's forthcoming (third) volume on the Palæontology of New York; and learn that it is making rapid progress towards completion. The volume will include the fossils of the Lower Helderberg Rocks or the upper part of the Upper Silurian, and the Oriskany Sandstone, generally regarded as Devonian. The author remarks that the subdivisions of the Lower Helderberg beds (into Upper Pentamerus limestone, Encrinal limestone, Delthyris shaly limestone, Pentamerus limestone and Tentaculite or water limestone) are distinguishable only for a short distance, while the formation as a whole reaches widely from the northeast to the southwest. The Oriskany Sandstone appears in some places to pass into the Helderberg rocks below, and in Maryland some of the fossils of the latter beds occur in it; and they may yet prove to blend intimately. But the separation of them in successive groups, "is fully justified by their physical condition in the State of New York."

In the southwest, the Oriskany sandstone contains many Crinoids similar in genera to those of the Lower Helderberg limestones. Among the

peculiar forms in both, is the genus Edriocrinus (Hall)—"a crinoid which is sessile in its young state and firmly attached to other bodies by the base of its cup, but becomes free as it advances and gradually loses all evidence of a cicatrix; the base becoming rounded and smooth, or very rarely preserving a depression or pit near the centre, which marks the original point of attachment.

The following is a list of the genera and number of species of Crinoidea and Cystidea in the Clinton and Niagara groups, and the Lower Helderberg and Oriskany Sandstone.

1. *Clinton and Niagara groups.*—Closterocrinus 1, Glyptocrinus? 1, Homocrinus 2, Glyptaster 1, Thysanocrinus 4, Dendrocrinus 1, Ichthyocrinus 1 (+ 1?), Lyriocrinus 1, Lecanocrinus 4, Saccocrinus 1, Macrostylocrinus 1, Eucalyptocrinus 3, Stephanocrinus 2, Caryocrinus 1, Melocrinus 1; Heterocystites 1, Callocystites 1, Apiocystites 1, Hemicystites 1; Palæaster 1.

2. *Lower Helderberg Group and Oriskany Sandstone.*—Homocrinus 1, Mariacrinus 8, Platycrinus 4 (the first occurrence of this genus); Aspidocrinus 2, Edriocrinus 2, Brachiocrinus 1, Coronocrinus 1; Anomalocystites 1, Sphærocystites 1, Apiocystites (=Lepadocrinus) 1; Protaster? 1.

The new genera are:

Mariacrinus,—the Astrocrinites of Conrad but not of other Authors. —Basal or pelvic plates four. Radial plates three in five series (3×5). Interradial plates three or more. Anal plates numerous. Brachial plates two resting on each third radial; beyond this point the structure differs in different species. Surface of plates marked by elevated radiating striæ or ridges which are more or less prominent, or by nodes or short spines. Arms varying in structure in different species. Resembles most *Glyptocrinus*.

Brachiocrinus.—Body unknown or none. Arms composed of numerous articulations arranged in single consecutive series (or of pentagonal joints in double series?). Base of arm rounded, without articulating surface. Tentacula composed of thickened node-like joints.

Edriocrinus.—Body subconical. Base solid, without division into plates: upper margin marked by six angles, with depressions between for insertion of radial plates. Radial plates five, inserted in the five larger depressions on the upper edge of the calyx. Anal plates two, the lower one inserted in the smaller of the six impressions on the upper margin of the calyx; the second anal plate placed on the upper edge of the first. Brachial plates numerous, consisting of thin plates in consecutive series resting upon the upper concave edges of the radial plates: pinnules subdivided above. Tentacula unknown. Proboscis unknown. Column none.

Aspidocrinus.—Base broadly circular, depressed hemispheric or scutelliform: upper margins plain or plicate exteriorly; the articulating edges irregular. Radial plates and arms unknown. Point of attachment for column distinct, small. The specimens are broad scutelliform bases of Crinoids, sometimes near hemispherical.

Coronocrinus.—Body very broad, hemispherical? towards the upper margins composed of numerous plates. Arms numerous, proceeding from the upper margin of the body: summit flat, composed of numerous small plates. Column and base unknown.

Sphærocystites.—Body spheroidal, wider than high. Arms in two principal pairs, with numerous bifurcations. Brachial sulci obliquely lobed. Mouth longitudinal? apicial: anus subapicial: ovarian opening upon the summit. Basal plates four; those of the series above not determined. Base depressed. Column unknown. The species have the general aspect of Callocystites or Lepadocrinus.

Anomalocystites.—Body semielliptical or semiovoid: sides unequal; the vertical outline oval or ovoid, plano-convex or concavo-convex; the transverse outline semielliptical, the base of which is straight or more or less concave: the two sides composed of an unequal number of plates. Basal plates three on the convex side, two on the concave side: second series, two large plates at the angles, and four (or five?) on the convex side; third series, four on the convex side, one at each angle, and a large plate on the concave side; a fourth, fifth, and sixth series of plates on the convex side, and a fourth series on the concave side. Base oblique, with the convex side longer, and a deep concavity for the insertion of the column. Pectinated rhombs apparently none. Arms unknown. Column deeply inserted into the body, composed of large joints above, becoming smaller below.

Lepadocrinus, noticed in the Annual Report of Mr. Conrad for 1840, is the same as Apiocystites, and has the priority of this last name in time.

5. *On the Cervus euryceros;* by Prof. De Morlot, (Proceed. Imp. Geol. Instit. Vienna, June, 1857, in Quart. Journ. Geol. Soc., vol. xiii, p. 35.)—M. de Morlot thus announces the discovery, by MM. Uhlmann and Jahn, of remains of the gigantic Elk (*Cervus euryceros = Megaceros hibernicus*) in association with works of human industry. On partially draining, in 1856, a small lake near Moosseedorf (Canton of Berne), an area of about 70 feet in length and 50 feet broad along the bank of the lower extremity of this lake was found to be paved more or less closely with posts of oak, aspen, birch, and elm, driven through two beds of peat into the marly bottom of the lake. A peat-bed, 3 or 4 feet thick, of exclusively vegetable origin in its upper part, includes many relics of human industry and art in its lower portion. Dr. Uhlmann collected nearly a thousand specimens; viz., fragments of pottery, stone-chisels, stone-arrowheads, pieces of cut bones, and perforated bear-teeth, without any traces of metallic objects. The lower ends of the posts have evidently been also worked into their pointed shape by means of stone-tools. The upper portion of the bed containing these remains exhibited traces of combustion and contained carbonized grains of barley.

Together with the above-mentioned works of art were found many fragments of the bones both of domesticated and of wild animals; viz., horned cattle, horses, swine, dogs of various size, goats, sheep, cats, elks, stags, aurochs, bears, wild boars, foxes, beavers, tortoises, several birds, and other animals still undetermined. An atlas and jaw, however, sent by M. Trogon to Prof. Pictet, of Geneva, were ascertained by this emi-

nent palæontologist to belong to *Cervus euryceros*. The length of the atlas is 0·265 metre, and its breadth 0·088 metre; both differing only by $\frac{1}{1000}$ from the measurements stated by Cuvier.

6. *Former Connection of Australia, New Guinea and the Aru Islands.*—Mr. A. R. Wallace in a paper on the Aru Islands, a group 150 miles South of Western New Guinea (Ann. and Mag. Nat. Hist., xx, Jan. 1858, p. 473), shows that the zoology of the Islands is closely related to that of New Guinea and Australia; and that shallow seas not only connect the two last, as others had before stated, but that they extend and include the Aru group. The depth of water over the whole to Australia is very nearly uniform at about thirty to forty fathoms. Mr. Wallace says:—

"But there is another circumstance still more strongly proving this connexion: the great island of Aru, 80 miles in length from north to south, is traversed by three winding channels of such uniform width and depth, though passing through an irregular, undulating, rocky country, that they seem portions of true rivers, though now occupied by salt water, and open at each end to the entrance of the tides. The phenomenon is unique, and we can account for their formation in no other way than by supposing them to have been once true rivers, having their source in the mountains of New Guinea, and reduced to their present condition by the subsidence of the intervening land."

Nearly one half of the Passerine birds of New Guinea hitherto described are contained in the author's collections made in Aru, and a number also of species in the other tribes.

The author farther observes on the absence of the peculiar East Indian types. "In the Peninsula of Malacca, Sumatra, Java, Borneo and the Philippine Islands, the following families are abundant in species and in individuals. They are everywhere *common birds*. They are the *Buceridæ*, *Picidæ*, *Bucconidæ*, *Trogonidæ*, *Meropidæ*, and *Eurylaimidæ*; but not one species of all these families is found in Aru, nor, with two doubtful exceptions, in New Guinea. The whole are also absent from Australia. To complete our view of the subject, it is necessary also to consider the Mammalia, which present peculiarities and deficiencies even yet more striking. Not one species found in the great islands westward inhabits Aru or New Guinea. With the exception only of pigs and bats, not a genus, not a family, not even an order of mammals is found in common. No Quadrumana, no Sciuridæ, no Carnivora, Rodentia, or Ungulata inhabit these depopulated forests. With the two exceptions above mentioned, all the mammalia are *Marsupials*; while in the great western islands there is not a single marsupial! A kangaroo inhabits Aru (and several New Guinea), and this, with three or four species of *Cuscus*, two or three little rat-like marsupials, a wild pig and several bats, are all the mammalia I have been able either to obtain or hear of."

7. *Earthquake in Italy*, (Athen., No. 1577.)—The phenomena which preceded and have followed the disastrous earthquake which has struck such a panic throughout this kingdom, have a remarkable and a separate interest from that of the afflicting details of the suffering occasioned by it, as many things occurred to show that before the event there was great subterranean agitation going on. Similar indications of existing agitation now continually manifest themselves. That Vesuvius has been in a

state of chronic eruption for nearly two years, and the wells at Resina for the last few months nearly dried up, I have already noted; that the kingdom has been in this interval, in various parts, alarmed by minor shocks of earthquake, may not be so generally known, but such is the fact, and to those signs of impending danger the Official Journal of the 30th of December adds the following: "The Syndic of Salandro (one of the Communes which has suffered much from the recent scourge) reports that for nearly a month at about two miles distance from the town a gas has been observed to issue from a water-course; the temperature of it was about that of the sun. A few days since, too, from another similar fosse, the same kind of gas issued. These exhalations were observed only in the morning, however; during the rest of the day they were not perceptible. On the 22d of December, they ceased altogether, and there was an expectation that hot mineral springs would burst forth from that spot." The Official Journal of the 2d of January relates another remarkable fact. In the territory of Bella, about two miles from the town, the earthquake on the night of the 16th of December levelled the neighboring hills, rolled the earth over and over, and formed deep valleys. Half an hour before the shock, a light as bright as that of the moon was seen to hover over the whole country, and a fetid exhalation like sulphur was perceived. On the morning following the shocks, which were accompanied by loud rumblings, a large piece of land, full 600 moggia (a *moggia* is something less than an acre), and at about the same distance from the town, was found encircled by a trench of from ten to twenty palms in depth, and the same in width. A letter from Vallo, now lying before me, and written much in detail, speaks of "those two terrible shocks," and of the innumerable minor shocks which have continued from the 16th of December up to the present time—the letter being written on the 29th of December. "A few minutes before the first shock," adds the writer, "a hissing sound was heard in the river, as if vast masses of stones were being brought down by a torrent. It is to be noted, too, that all the dogs in the neighborhood howled immediately before the first awful shock."

Let us visit some of the ruined places at the centre of the disaster;—and I will speak in the words of a gentleman who has just returned: "I found the country seamed with fissures, which had at first been wide, but which gradually closed. The ground was heaving during the whole time of my visit to Polla. Once a beautifully situated township, with 7,000 souls, it is now half in ruins, and the survivors were sitting or walking about, telling us of their misery, and lamenting more that there were no hands to take out the dead or rescue the living. Two country people were groping amongst the stones of a building; one found a body, and throwing a stone towards the face called the attention of the other, 'That perhaps is some relation of yours,' but the body was not recognized. I tried to get food at a *trattoria*, the only house standing, at the corner of a street; but the proprietor, who was by our side, repulsed me, and refused to go in, saying that the moon has just entered the quarter, and we should have another earthquake. In most of these places, as in Naples, the deep, heavy rumblings which preceded and accompanied the earthquake have been much dwelt upon." On the night of the 26th of De-

cember, the little town of Sasso, near Castelabbate, consisting of one long street, was separated in two by the sudden opening of a fissure through its entire length, each side remaining separated from the other by a considerable interval—and so it stands. On the 28th and 29th of December, both in Sala and Potenza, strong shocks were felt, followed by many others of a less intense character, and these still continue. The consequences will be that even those houses which were only cracked will give way, and those which were feeble will be reduced to ruins. In Naples, too, the shocks continue producing vibrations of the doors and windows; and in one instance, I have heard ringing of the bells. The common report is, that since the 16th of December we have had eighty-four shocks in the capital. It is not at all improbable if every vibration is counted as one, and if the great subterranean agitation, which is now going on, be taken into account. Every one looks really with anxiety to Vesuvius, and prays, not for curiosity only, for an eruption. The indications of so desirable a result seem to be on the increase. A person who resides at Resina says, that on the night of the 29th, from 10 P. M. to 5 A. M. of the 30th ult., the whole town was in a state of continued vibration. Every three minutes a sound was heard as of a person attempting to wrench the doors and windows out of their places, followed by a quiver. The next morning the mountain was observed to vomit forth much smoke and a cloud of ashes. Friends, too, who reside at Capo di Marte, near the city, speak of the deep thunders which they hear from the mountain in the stillness of the night. The same phenomena are observed at Torre del Greco. I must, also, advert to the manifest lowness of the sea, which seems to-day to have receded from the land. I noticed this fact in my last letter, and tried to explain it as consequent upon the neap tides: but the same thing continues; and unless it has been occasioned by the long continuation of a land wind, the conclusion is inevitable that there has been an upheaving of soil. It would be rash, however, to come speedily to so important a decision. How this state of things will terminate, it is impossible to say; but that some great change is pending, there is but too much reason for supposing.

Some English gentlemen who have just returned from the scene of disaster give the following interesting though harrowing details:—"Before arriving at Pertosa, we found the houses on either side of the road thrown to the ground; the landlord of a tavern now abandoned told us that he had the good fortune to escape with his wife, but that his child and servant had been both killed. He himself bore the marks of a heavy blow on his face. The population of this place was about 3,000, and 143 bodies only had been dug out on the 1st of January; whilst 200 more were known to be missing. The whole town was destroyed, with the exception of six houses, which were in a falling state. Between Pertosa and Polla the strength and caprice of the earthquake were made manifest in a remarkable way. Crossing a deep ravine, we found the road on the opposite side carried off 200 feet distant from its former position: the mountain above it had been cleft in two, revealing to a great depth the limestone caverns in the bowels of the earth. The ground was seamed with fissures; and we could put our arms into them up to the shoulders. Polla has a population of 7,000 persons:—1,000 had fallen

victims, of whom 567 had been dug up and buried; the work of disinterment was continuing slowly, but the stench here and elsewhere, from the bodies, was insufferable. Three shocks of an earthquake were felt on this day, January 1. The first was very early in the morning; the second about half-past 12. When we were standing on the ruins of a church, the ground began to heave under our feet and the subterranean thunders to roll. We immediately fled from the spot, but were nearly overwhelmed as the wall of a bell-tower fell close upon our heels, and a leaning house, in an inclining state, came down within twenty feet of us. The frightened people immediately formed a procession, and headed by the priests, bearing the crucifix and an image of the Madonna, lashed themselves with ropes as they walked. On leaving the town, we rested on the wall of a bridge just outside, where some priests begged us to rise, saying we were in danger, for the ground was continually trembling. Whilst sitting there, we felt the third shock, and required no other hint." At the last moment, I add, from official documents, that upwards of 30,000 are returned as dead, and 250,000 living in the open air.

8. *Grenelle Artesian well*, (Athen., No. 1577.)—The artesian well on the plain of Grenelle, at Paris, built in the years 1831 to 1841 by the engineer, M. Merlot, has become the finest ornament of the Place Breteuil. According to the plans of the architect, M. Joon, a cast-iron tower, of about 140 feet in height, has been erected on the stone basis, in the centre of which a winding staircase with three landing-places, each of which has its own fountain, leads to the platform of the graceful building. On the top one enjoys a beautiful view, and, under the three watery tents, produced by the three *jets d'eau* of the well, the coolest and most refreshing of shades.

9. *Chemische und Chemisch-Technische Untersuchung der Steinkohlen Sachsens;* von W. Stein, Prof. der Chemie an der Königl. Polytechn. Schule zu Dresden. 98 pp., 4to. Leipzig, 1857.—This memoir contains the results of an extended research into the composition, and the economical value for fuel and lighting of the coal of the Saxon coal beds. The following are a few of the results of the analyses:

	Ash	Carb.	Hyd.	Nit.	Ox.	Sulph.	
Culm coal,							
1. Berthelsdorf,	28·571	55·984	3·878	0·233	11·334	2·269.	G.=1·217
Zwickau coal,							
2. Zwickau,	2·640	77·211	5·149	0·242	13·321	1·789.	G.=1·294
3. "	4·950	81·410	5·222	0·345	5·735	2·955.	G.=1·192
Plauen coal.							
4. Hänichen,	12·607	71·258	3·882	0·493	11·478	1·149.	G.=1·353
5. Potschappel,	14·521	66·696	3·481	0·225	15·046	0·796.	G.=1·340

Volatile products of distillation in 2, 32·518; in 3, 37·333; in 4, 28·690; in 5, 21·531.

10. *Tooth of the American Elephant.*—Remains of the American extinct Elephant (or Mammoth) occur 60 miles north of the City of Mexico. One fine tooth in our possession, received from Mr. E. L. Plumb, comes from the Barranca of Regla, near Real del Monte in that region. Others are found in beds which are overlaid by lava.—Eds.

11. *Second Report on the Geological Survey of Kentucky*, made during the years 1856 and 1857; by David Dale Owen, Principal Geologist, assisted by Robert Peter, Chemical Assistant, Sidney S. Lyon,

Topographical Assistant. 392 pages, large 8vo.—The geological survey of Kentucky, as this second report evinces, is carried forward with energy and ability, and with important results to the State. The general report by Dr. Owen, takes up first Agricultural Geology, under which after a chapter of general remarks on soils, he treats of Kentucky soils; next chemical economic geology, comprising coals, iron ores, limestones, mineral springs and well waters; next stratigraphical geology.

The Falls of the Ohio are a noted locality for fossil corals. The following is given as a section of the rocks at that place, commencing above with the Devonian black slate, a well known horizon in the west.

1. Black bituminous slate or shale.
2. Upper crinoidal, shell, and coralline limestones, consisting of
   a. White or yellowish-white earthy fractured layers, containing vast numbers of *Crinoids* (*Actinocrinus abnormis*, most common), a *Favosite*, a large *Leptæna*, and *Atrypa prisca*.
   b. Middle layers; containing a few *Cystiphylla*.
   c. Lower layers; containing many *Cystiphylla*, a *Syringopora*, and on Corn Island, remains of fishes, hence called the Upper Fish bed.
3. Hydraulic limestone, an earthy magnesian limestone; contains *Atrypa prisca*, a *Spirifer*, &c. Thickness 21 feet and less.
4. Lower crinoidal, shell, and coralline limestones; consisting in a great measure of comminuted remains of Crinoids, and containing *Spirifer cultrijugatus*, *Atrypa prisca*, a *Leptæna* near *euglypha*, and remains of fishes. Thickness 3 to 11 feet.
5. Olivanites bed; thickness 6 inches near the mill on the south side of the Ohio, 6 to 7 feet on Fourteen-Mile Creek.
6. A cherty band, charged with *Spirifer gregaria*, and many small hemispherical masses of *Favosites spongites*, thickness 1 foot; next below, a layer containing *Conocardium subtrigonale*, with large hemispherical masses of *Stromatopora* and a *Ceriopora?* 3 to 5 feet thick; next, the Lower Fish Beds, a limestone stratum 19 feet thick, containing a large and beautiful species of undescribed *Turbo*, a large *Murchisonia*, a *Conocardium*, *Spirifer gregaria*, a *Leptæna* and some small *Cyathophyllidæ*. The Conocardium layer is light gray; the Leptæna layer is two feet above it. The Fish remains are mostly about three feet above the Turbo bed, but are also distributed in other parts of the stratum.
7. Main beds of coral limestones: consisting of
   a. Dark grey bed, containing hemispherical masses of *Favosites maxima* of Troost, *Zaphrentis gigantea*, immense masses of *Favosites basaltica*, sometimes as white as milk, *Favosites polymorpha*.
   b. Black coralline layers, being almost a complete mass of fossilized corals, including *Cystiphylla*, *Favosites cornigera*, *Zaphrentis gigantea*, *Syringopora*, etc.

These Devonian beds rest upon an Upper Silurian stratum containing the Chain Coral (Catenipora).

Other sections are given and much important detail.

The chemical report of Dr. Robert Peter, exhibits a large and almost incredible amount of research. 206 analyses are reported, 7 of iron ores, 43 of soils, 31 of limestones, 30 of coals, 16 of mineral waters and salts, and others of rocks and ores. In the analyses of coals, the author has

not only ascertained the proportions of moisture, volatile matter, ashes and coke, but also the chemical composition of the ashes, the proportion of sulphur, and the relative proportions of carbon, hydrogen, oxygen and nitrogen.

The *Breckenridge cannel coal* afforded by *proximate* analysis (p. 211):

Moisture 1·30, volatile combustible matters 54·40, carbon in the coke 32·00, ashes 12·30 = 100.

Examining other specimens, the volatile matters varied from 55·70 to 71·70 per cent, the coke from 28·30 to 44·30, the ashes from 7·0 to 12·30 per cent, in the undried coal. The ashes contained

Silica 3·49, alumina and oxyd of iron 7·78, lime 0·55, magnesia 0·39 = 12·21.

By *ultimate* analysis it afforded

Carbon 68·128, hydrogen 6·489, sulphur 2·476, nitrogen 2·274, oxygen and loss 5·833, ashes 14·800 = 100.

Excluding the ashes and sulphur, the Breckenridge coal and the Boghead of Scotland compare as follows:

	Carbon.	Hydrogen.	Nitrogen.	Oxygen.
Breckenridge,	82·355	7·844	2·749	7·051
Boghead,	80·487	11·235	0·874	6·726

The Breckenridge coal is already noted for the mineral oils obtained from it by distillation. It affords per 100 lbs. 32 lbs. of crude oil. About 6000 gallons of crude oil are distilled at the company's works near Cloverport per week, and manufactured by distillation and purification into benzole, naphtha, illuminating and lubricating oils, and paraffine.

Haddock's cannel coal (Owsley County) is also a coal yielding a large amount of oil, it giving 55 to 60 gallons of crude oil (or 27 to 30 purified) to the ton of coal. In the following table different Kentucky coals are compared as to their yield of oils, from 1000 grains each.

	Crude oils.	Ammoniacal water.	Coke.	Gas (cub. in.)
Breckenridge cannel,	318·20	52 10	455	445
Haddock's cannel,	248·50	54·50	589	370
Union company's coal, bottom part,	148	38	750	465
Mulford's five-foot, or main coal,	136·50	64·75	684	567
Robert's, or Muddy river coal,	102·10	119·80	659.50	370
Ice House coal,	108	73	714	465
Youghioghany coal,	136	52	710	545.

The topographical report of Mr. Lyon contains an account of observations upon the Eastern and Western Coal Fields, tracing out the beds of coal, and the features of the country, and illustrating the subject by many sections. Near Owingsville in Bath county (eastern part of the State), a section extending from the Lower Silurian (Blue limestone) to the beds at the base of the coal measures in Carter Co., showed a total thickness of 2,520 feet; of this 100 were the soft beds of the coal measures; 75 to 100 millstone grit (but thinning out to 14 feet on the Ohio near the mouth of Tigert's creek); 100 feet muddy shale with thin beds of limestone; 350 feet subcarboniferous limestone (thinning out to 12 feet on the Ohio); 20 to 75 feet of grindstone grit; 725 Waverley sandstone of Ohio; 120 black Devonian shale; 700 buff porous limestone of Lewis, Fleming and Bath Cos.; 75 limestone producing red earth by disintegration; 100 slaty mudstone, thin-bedded; 150 Lower Silurian, containing

Leptæna alternata, Orthis occidentalis, Orthis (*Spirifer*) *Lyra,* and also *Murchisonia bicincta?*

This volume is to be soon followed by another giving the remainder of the Report.

12. *New species of Fossil Plants from the Anthracite and Bituminous coal-fields of Pennsylvania;* collected and described by Leo Lesquereux, with Introductory observations, by H. D. Rogers, (Jour. Bost. Soc. Nat. Hist., vi, No. iv, 409).—This memoir contains descriptions of 106 new species of coal-plants from the coal-fields of Pennsylvania. Prof. Rogers, in his introductory observations, states that M. Lesquereux has found that out of over 200 species examined by him, 100 are "identical with species already recognized in the European coal-fields, and some 50 more of them show differences so slight that a fuller comparison with better specimens may result in their identification likewise;" moreover "those new species which seem to be restricted to this continent are every one of them in close relationship with European forms." The new species are of Calamites 2, Asterophyllites 5, Annularia 1, Sphenophyllum 2, Nœggerathia 3, Cyclopteris 5, Neuropteris 13, Odontopteris 2, Sphenopteris 8, Hymenophyllites 3, Pachyphyllum (new genus) 5, Asplenites 1, Alethopteris 5, Callipteris 1, Pecopteris 7, Crematopteris 1, Scolopendrites 1, Caulopteris 2, Stigmaria 5, Sigillaria 9, Lepidodendron 10, Lepidophyllum 6, Brachyphyllum 1, Cardiocarpon 3, Trigonocarpum 1, Rhabdocarpus 1, Carpolithes 3; and Pinnularia 5 (named but undescribed).

The new genus *Pachyphyllum* is thus described. Frond large, thick, membranaceous, broadly oval or lanceolate in outline, either pinnately or irregularly lobed; radical or borne on a thick rachis? divisions short, lanceolate, obtuse, or long linear-flexuous; nerves thick, compound and parallel near the base, separating above and solitary in each division or disappearing totally. The *Schizopteris Lactuca* of Sternberg is referred to this genus.

13. *Illinois Geological Survey. Abstract of a Report on Illinois Coals, with Descriptions and Analyses, and a General Notice of the Coal-fields;* by J. G. Norwood, M.D. 94 pp., 8vo. Chicago, 1858. Published by order of the Governor.—Fifty-eight pages of this Report are occupied with analyses of coals from different beds in Illinois, with brief notices of the localities. The few points noticed in the analyses are loss in coking, total weight of coke, moisture, volatile matters, carbon in coke, ashes, carbon in the coal, with the specific gravity. The specific gravities vary between 1·21 and 1·3, excluding a few very impure; and the volatile matters between 30 and 44 per cent; the ash mostly 5 to 8 per cent.

The Report contains a small colored geological map of the State, giving the general outlines of the coal-fields and of the formations on its borders. The author remarks on the fact, that the coal-field is not a continuous one, but throughout its extent is broken into patches by uplifts of the millstone grit and carboniferous limestone; the displacements having been so great as to produce tiltings at all angles up to vertical. He states that the lower coal-beds were deposited in basins thus formed; that there was then a farther displacement and erosions, and these new valleys and basins were filled with new deposits of coal, and so on up to the termination of the carboniferous epoch. We regret that the Report

is geologically so meagre, as a few facts and sections proving the exact age of these uplifts would be of great interest. The details are promised in the full Geological Report.

These uplifts were alluded to at the Albany meeting of the American Association by Mr. Worthen, who stated that the strike of them was northwesterly, and therefore parallel to the Rocky mountain range.

14. *Denkschriften der Kaiserlichen Akademie der Wissenschaften Mathematisch-naturwissenschaftliche Classe.* Vols. 11 and 12. 1856.—The volumes of Transactions of the Vienna Royal Academy are not exceeded by any others in the world in typography, beauty of illustration, or the value of the science they contain. In Geology, the contents of the *eleventh* and *twelfth* volumes are as follows:—

On the Cephalopods of the Lias of the northeast Alps, by F. R. v. Hauer, 86 pp. 4to, with 25 plates (of Ammonites and all highly beautiful).

On the Palæontology of the Thuringian Forest, by R. Richter and Fr. Unger. 100 pp., 16 plates.

On the Fossil Fishes of Austria, by J. J. Heckel. 88 pages, with 15 plates.

On the Gasteropoda of the Trias of the Alps, by Dr. M. Hörnes, with 3 plates.

On Foraminifera of the Family Stichostegues of D'Orbigny, by J. L. Neugeboren, with 5 plates.

There are also other papers,—by Dr. K. M. Diesing on the Acanthocephala and Cephalocotylea (Intestinal worms) with many fine plates; Prof. J. Hyrtl on the Anatomical structure of the Mormyrus and Gymnarchus; K. Kreil on Magnetic observations at Vienna; K. Langer on the circulating system in the Anodonta; J. Grailich on the refraction and reflection of light by twin faces; Ignaz Heger, Auflösungsmethode für Algebraische Buchstabengleichungen mit einer einzigen unabhängigen Buchstabengrösse.

15. *On the part which the Silicates of the Alkalies may play in the Metamorphism of Rocks;* by T. Sterry Hunt, Esq., of the Geological Survey of Canada, (Proc. Roy. Soc., in L. E. and D. Phil. Mag., xv, 68.) —In my last communication to the Royal Society on the Metamorphic Silurian Strata of Canada, I endeavored to show, from the results of analyses of the altered and unaltered rocks, that it is the reaction between the siliceous matters and the carbonates of lime, magnesia, and iron of the sedimentary deposits, which has given rise to the serpentines, talcs, pyroxenites, chlorites, and garnet rocks of the formation. I then cited the observation of Bischof that silica, even in the form of pulverized quartz, slowly decomposes these carbonates at a temperature of 212° F., with evolution of carbonic acid; the same author mentions that a solution of carbonate of soda has the power of dissolving quartz under similar conditions.* Desiring to verify these observations, I have since made the following experiments.

Colorless crystalline quartz was ignited, finely pulverized, and then boiled for an hour with a solution of its weight of perfectly pure carbonate of soda; the amount of silica thus dissolved was 1·5 per cent of the

* Bischof's Chem. and Phys. Geology, Eng. Edition, vol. i, p. 7.

quartz, but on repeating the treatment of the same quartz with a second portion of the carbonate, only ·35 per cent was dissolved. The object of this process was to remove any soluble silica, and the quartz thus purified was employed for the following experiments, which were performed in a vessel of platinum.

I. 1000 parts of quartz and 200 of carbonate of soda were boiled with water for ten hours, and the mixture was several times evaporated to dryness, and exposed for a few minutes to a temperature of about 300° F. The amount of silica taken into solution was 12 parts.

II. A hydrocarbonate of magnesia was prepared by mingling boiling solutions of sulphate of magnesia and carbonate of potash, the latter in excess; the precipitate was washed by boiling with successive portions of water. 1000 parts of quartz were mixed with about as much of this magnesian carbonate and boiled as above for ten hours. An excess of hydrochloric acid was then added, the whole evaporated to dryness, and the magnesian salt washed out with dilute acid. The residue was then boiled for a few minutes with carbonate of soda, and gave 33 parts of soluble silica.

III. A mixture of 1000 parts of quartz, 200 of carbonate of soda with water, and an excess of carbonate of magnesia was boiled for ten hours, and the residue, treated as in the last experiment, gave 148 parts of soluble silica. The alkaline liquid contained a little magnesia, but no silica in solution. That the soluble silica was really combined with magnesia was shown by boiling the insoluble mixture with sal-ammoniac, which, dissolving the carbonate, left a large amount of magnesia with the silica. This silicate was readily decomposed by hydrochloric acid, the greater part of the silica separating in a pulverulent form.

The third experiment was suggested by some observations on the reactions of silicate of soda with earthy carbonates. Kuhlmann has remarked the power of carbonate of lime to abstract the silica from a boiling solution of soluble glass,* and it is known that alumina exerts a similar action. I have found that when artificial carbonate of magnesia in excess is boiled with a solution of silicate of soda, the latter is completely decomposed with the formation of carbonate of soda, and a silicate of magnesia which gelatinizes with acids; and I have long since described this reaction in the evaporation of alkaline mineral waters.† This mutual decomposition of carbonate of magnesia and silicate of soda, conjoined with the power of carbonate of soda to dissolve silica, leads to a curious result. If we boil for some hours a mixture of ignited silica, obtained from the decomposition of a silicate by an acid (and consequently readily soluble in all alkaline carbonates), with a small portion of carbonate of soda and an excess of hydrocarbonate of magnesia, we obtain a dense powder which contains all the silica united with magnesia, and may be boiled with carbonate of soda and sal-ammoniac without decomposition. It is obvious from the above experiments that similar results may be obtained with quartz, although the process is much slower; it would doubtless be accelerated under pressure at a somewhat elevated temperature, which would enhance the solvent power of the alkaline carbonate.

* Comptes Rendus de l'Acad. des Sciences, Dec. 3rd and Dec. 10th, 1855, where will be found many important observations on the alkaline silicates.

† Reports of the Geol. Survey of Canada, 1851-53-54.

Silicates of potash and soda are everywhere present in sedimentary rocks, where decomposing feldspathic materials are seldom wanting, and these salts in the presence of a mixture of quartz and earthy carbonates, aided by a gentle heat, will serve to effect a union of the quartz with the earthy bases, eliminating carbonic acid. A small amount of alkali may thus, like a leaven, continue its operation indefinitely and change the character of a great mass of sedimentary rock. Such a process is not only a possible but a necessary result under the circumstances supposed, and we cannot, I think, doubt that alkaline silicates play a very important part in the metamorphism of sedimentary rocks, which are composed for the most part of earthy carbonates, with siliceous, aluminous, and feldspathic materials.*

The direct action between the carbonates and silica must necessarily be limited by their mutual insolubility, and by the protecting influence of the first-formed portions of earthy silicate; but with the solvent action of a small portion of alkali, which is changed from silicate to carbonate, and then back again to silicate, the only limit to the process would be the satisfying of the mutual affinities of the silica and the basic oxyds present.

16. *On the Extinct Volcanoes of Victoria, Australia;* by R. Brough Smyth, Esq., C.E., F.G.S., (Proc. Geol. Soc., in L. E. and D. Phil. Mag., xv. p. 74.)—The district in Southern Australia in which lavas, basalts, and other evidences of recent igneous action are found, extends from the River Plenty (a tributary of the Yarra), on the east, to Mount Gambier on the west. Its most northern point is Macneil's Creek (a tributary of the Loddon), in 37° S. lat., and its most southern point is Belfast, in 38° 21′ S. lat. Its extreme length is 250 miles, and its extreme breadth about 90 miles.

The following were enumerated and described as the most distinctly marked crateriform volcanic hills:—

1. A hill near the source of the Merri Creek, on the Dividing Range, about 25 miles north of Melbourne, and already described by Mr. Selwyn, the Government Geologist. 2. Mount Atkin, about 1500 feet above the sea-level. 3. Mount Boninyong, adjacent to the Ballarat Gold-fields. 4. Larnebaramul or Mount Franklyn. 5. Mount Rouse. 6. Several crateriform hills around Lake Koraugamite, and the often conical hills known as the Stony Rises. 7. Tower Hill, between the towns of Warnambool and Belfast, and close to the coast. In the last-mentioned instance the scoria has been found by well-sinkers to overlie, at the depth of sixty-three feet, the original surface of the ground, covered with coarse grass, such as that now found growing, and amongst this dry, but not scorched, grass the workmen are said to have found some living frogs.

Over nearly the whole extent of Victoria there are masses of intrusive basalt, in some places columnar, breaking through both the granite and the palæozoic strata, and occasionally through the overlying Tertiary (Miocene) beds also. Extensive denudation has destroyed the probably overlying portions of these old basaltic outbursts, both before and after

* It is well known that small portions of alkalies are seldom or never wanting in the earthy silicates, such as serpentine, talc, pyroxene, asbestus, epidote, idocrase, and even beryl and corundum. See the memoir of Kuhlmann already cited.

the tertiary period. A newer series of eruptive trap-rocks, sometimes as dense and hard as the older basalts, but more frequently vesicular and amygdaloidal, pierce the old tertiary and also the post-tertiary beds, or the later quartzose and auriferous drifts. These newer basalts and lavas were probably erupted at a period when considerable areas, both north and south of the main-coast range, were submerged; and the lavas cooled rapidly and not under very great pressure. These eruptions do not appear to have disturbed the Tertiary beds, which are usually found nearly horizontal. After these newer basaltic lavas were erupted and denuded, and after the deposition of the overlying pleistocene drift, some of the volcanoes were still acting, though not so energetic as previously, emitting porous lavas and pumice; and at a still later period, volcanic ash and scoria, such as that which rests on the ancient humus at Tower Hill, and that of Mount Leura and the Koraugamite district, were thrown out when the igneous force was almost exhausted. Mr. R. B. Smyth pointed out the interest attached to the extinct volcanos of Victoria as connected with the great volcanic chain extending from the Aleutian Islands to New Zealand; and concluded with some observations on the recent occurrence of earthquake-movements in Southern Australia, and on the coast-line, as having reference to the probably not yet exhausted force of the volcanic foci of that region.

17. *On the occurrence of Marine Animal Forms in Fresh-water.*—A translation of a paper by Dr. E. von Martens, on this subject, is published in the Annals and Magazine of Natural History, [3], i, 50. The facts are important in their bearing on the determination of the marine or freshwater character of geological formations from their fossils.

18. *Wollaston Medal.*—The Geological Society of London at the anniversary meeting, Feb. 25, 1857, awarded the Wollaston medal to M. Barrande, the distinguished palæontologist, and the balance of the proceeds of the Wollaston Donation Fund to Mr. S. P. Woodward, author of the excellent "Manual of the Mollusca," and now engaged on a "Manual of the Radiated Animals."

III. BOTANY AND ZOOLOGY.

1. *DeCandolle's Prodromus*, Part II of Vol. XIV (pp. 493—706) was published near the close of the past year. It contains the *Thymelæaceæ* by Meisner, the *Elæagnaceæ* by von Schlechtendal, the *Grubbiaceæ* by DeCandolle, resting merely on one of those outlying or anomalous genera which there is too great tendency to raise to ordinal importance, merely because the author knows not what to do with them,—and *Santalaceæ* by DeCandolle. Of the first order we have only *Dirca*, peculiar to this country, and with no congener known. There is nothing to add respecting our three species of *Elæagnaceæ*. As to our few *Santalaceæ*, it is interesting to remark that one of our characteristic genera, *Pyrularia* (the Oil-nut), is found to have two representatives in the Himalayas (*Sphærocarya*, Wall.), and apparently two more in southern India (*Scleropyrum*, Arn.). Also that an European species is introduced into our *Comandra* (the *Thesium elegans* of Rochel), and the genus itself shown to be hardly distinct from *Thesium*. And *Darbya*, Gray, published in this Journal twelve years ago, is reduced to a subgenus of *Comandra*,—to which we

are not disposed to object. But we take the new species of true *Comandra*, *C. pallida*, to be a mere variety of *C. umbellata*; which, by the way, we did not state to be eight or ten *feet*, but only as many *inches* in height. DeCandolle thinks that the hairs which connect the anthers of *Comandra*, and of most *Thesia* also, with the perianth, belong to the latter, not to the former, as the generic name implies. Our own observations, and especially some made by Mr. H. J. Clark upon very young flower-buds, confirm this view. The discovery, announced in this Journal in 1854, that the striking genus *Buckleya*, Torr., is truly dichlamydeous in the female flowers, proves a capital fact for M. DeCandolle; who draws from it the confident inference that the floral envelop which in all other plants of the order occurs alone, and has the stamens opposite its lobes, is *corolla* and not calyx, and consequently so in the *Loranthaceæ* and *Proteaceæ* also. Our author's views are presented in detail in an article, *Sur la Famille des Santalaceæ*, in the *Bibliothèque Universelle*, published last autumn, and they appear well-nigh convincing. An analogous case is found in *Zanthoxylum* (only here the suppression is the rare case), *Z. Americanum* plainly wanting that which in *Z. Carolinianum* is the corolla (*Genera Illustr.* 2, p. 148). *Nyssa* offers a good instance of the limb of a calyx so reduced as to have escaped notice, until four years ago. For what to DeCandolle seem to be petals (p. 622, note in char. of order *Santalaceæ*), were *seen* to be so, and the observations recorded in the 5th volume of the *Memoirs of the American Academy*, p. 336, and afterwards extended in the *Manual Bot. U. S.*, ed. 2, p. 162 (1856). It is singular that DeCandolle should remain so uncertain of the place of *Nyssa* in the Natural System. If he will compare it and *Mastixia* with *Cornus* he will surely be convinced that *Nyssa* is a true Cornaceous genus. So of *Cerallia*, the true place of which our author seems not to know, although given in the *Flora of North America* many years ago, under the sanction (we may add) of the very highest authority. Indeed, so plain is its relationship to *Gronovia* that Fenzl soon saw and corrected his mistake in referring the genus to *Calycereæ*. And if at this day any should doubt that these are Loasaceous plants, let them turn to the characters of *Petalonyx*, in *Mem. Amer. Acad.*, 5, p. 319.

Leaving these details, let us consider our pleasing prospect in respect to the continuation (at least through the *Dicotyledoneæ*) of the great work upon which the DeCandolles, father and son, and other excellent botanists, have bestowed so much labor and talent. The great order of *Lauraceæ* was to have been included in the present volume. It would have extended the volume unduly. But, unfortunately, or fortunately, as the case may be, Professor DeVriese has gone to Java on a government mission without finishing the work; and the indefatigable Meisner now takes it in hand. It is to form the leading part of volume 15, the *Begoniaceæ* by DeCandolle himself, and the *Aristolochiaceæ* by Duchartre being appended, and perhaps the *Euphorbiaceæ*, also by DeCandolle, except the genus *Euphorbia* which Boissier undertakes. The 16th volume is intended to commence with the *Urticaceæ* proper, by Weddell, or the *Monimiaceæ* by Tulasne. We are pleased to learn that Prof. Andersson of Stockholm is to elaborate the *Salicineæ*; and we beg of all North American botanists that they will collect for him all the native Willows

and Poplars of their districts, taking pains to procure blossoms, foliage, and fruit from the same trees. And for DeCandolle himself, who will probably undertake the *Cupuliferæ*, we likewise ask for good and copious specimens of every species or form of our American Oaks. Specimens communicated to the writer of this article will be duly forwarded, and will doubtless be very useful. Such arrangements are made as to render it probable that the *Dicotyledoneæ* may be completed in the Prodromus in the course of three or four years. A. G.

2. *Dr. Hooker's Flora of Tasmania* has been issued as far as to Part V, which completes the first volume, and the Dicotyledonous class, *Coniferæ* included: 359 pages, and 100 admirable plates. The work is published by Lovell Reeve, London, in the same form and style as the *Flora Antarctica* and the *Flora of New Zealand*. It is enough to say that the work is of the very highest character, and that it abounds with important observations upon the structure and affinities of plants. One volume more will finish this series of high southern Floras, which—although they embrace only a part of the author's botanical writings—would appear sufficient to represent a life-time of arduous scientific labors. A. G.

3. *Journal of the Proceedings of the Linnæan Society* (Botany); No. 6, 1857.—Dr. Thomson's interesting paper upon the embryo and germination of *Barringtonia* and *Careya* is concluded. The embryo is shown to be exalbuminous, essentially a macropodous radicle, destitute of cotyledons, developing from one end a nearly naked plumule, and from the other a primordial slender root. Drs. Hooker and Thompson continue, in a second series, their *Præcursores ad Floram Indicam*. They here take up a group of related orders, consisting of "*Saxifrageæ* (including *Hydrangeæ*, &c.), *Crassulaceæ*, *Droseraceæ*, *Parnassieæ*, *Grossularieæ*, *Hamamelideæ*, and *Philadelpheæ*. The very close relationship of the group or alliance to *Rosaceæ* on the one hand and to *Cornaceæ* on the other is pointed out. The resemblance of *Parnassia* to *Saxifraga*, as indicated by Brown, is insisted on, and the affinity strengthened by the discovery that the stamens advance in pairs to the stigma, as in the latter genus, and by the disposition to an adhesion of the calyx-tube with the base of the ovary, which (somewhat evident even in our *P. Caroliniana*) is very striking in several species. We are pleased to find, however, that Dr. Hooker retains *Parnassia* as a distinct order, on account of the 'staminodia' and the exalbuminous seeds. But he omits all mention of the anomalous position of the stigmas, which is decidedly anti-saxifrageous, as also is the division of the styles or stigmas in *Droseraceæ*. (There is an oversight or misprint on p. 78, in speaking of the *parietal* placentation of *Elodea*.) The transference of *Droseraceæ* to the Saxifragal alliance *en suite* to *Parnassieæ*, is surely a happy thought, naturally suggested by our author's discovery of the perigynous character of some Antarctic species, and by the other obvious points of resemblance with *Parnassia*. But we demur to the statement that "*Droseraceæ* and *Grossularieæ* seem to be rather aberrant members of *Saxifrageæ* in its extended significance, than separate orders." But, if there be here "too much easiness in admitting variations" of the order, there is on the other hand, as it seems to us, "too much stiffness in refusing" to admit the *Philadelphieæ*, which, as our authors limit the groups, are distinguishable from *Saxifragaceæ* by

no one assignable character. If limited to *Philadelphus* and to *Carpenteria* (which is as it were a *Philadelphus* with an almost free ovary) the group may indeed be distinguished by the convolute æstivation of the petals; but this is of no great moment in such a case, especially since *Jamesia* exhibits a transition into the ordinary imbricative mode. (See Bot. U. S. Expl. Exped., 1, p. 663, note.) In *Pileostegia* our authors bring to our knowledge an interesting new Hydrangeous genus. They also have a new Crassulaceous genus, *Triactina*, a sort of *Sedum* with the carpels reduced to three and connate half way up. So that, with this genus, *Penthorum* and *Diamorpha*, on the one hand, and *Spiræanthemum* on the other, the interval between *Crassulaceæ* and *Saxifragaceæ*, so far as respects technical distinctions, is completely bridged over. A. G.

4. *Plantæ Indiæ Bataviæ Orientalis, quas .... exploravit* Casp. G. C. Reinwardt. Digessit et Illustravit Guil. H. de Vriese. Leyden. Fasc. I, 1856. Fasc. II, 1857, pp. 160, tab. 1–8. Roy. 4to.—The venerable Reinwardt died in the year 1854, and his botanical collections, made in the Dutch East Indies about thirty years ago, were bequeated to the herbarium of the Leyden Botanic Garden; and their publication in very handsome style has been commenced by Professor De Vriese, aided by other able botanists. The first fasciculus comprises the *Gesneriaceæ*, *Ternstræmiaceæ*, *Sapotaceæ*, *Myrtaceæ*, and *Dilleniaceæ* by De Vriese, and the *Hepaticæ* by Dr. Van der Sande La Coste. *Saurauja*, of which many species are here described, is taken as the type of a distinct order, but nothing new is suggested in respect to its affinities. We suspect that Planchon is right in considering it as of the Ericaceous type. Several species are said to have their styles united at the base, and a trigynous species is said to have them united up to the middle. This militates against *Draytonia*. The second fasciculus contains the *Araliaceæ* by Miquel, the *Myristicaceæ*, by De Vriese, the *Gramineæ* by L. H. Buse, the *Musci Frondosi* by La Coste, the *Urticaceæ* by Weddell, and the *Cyperaceæ*, *Aroideæ*, *Combretaceæ*, *Saxifragaceæ*, &c., and *Rubiaceæ* (commenced), by Miquel. Miquel's new Cunoniaceous genus *Spiræopsis* is much closer to *Weinmannia* than our *Spiræanthemum*. The plates of this work are truly beautiful. A. G.

5. *Botanical Necrology for* 1857.—*Charles Girou de Buzareingues* of the South of France.—*A. N. Desvaux*, who was a botanist of some consequence in the earlier part of the century, when he was the editor of a well known Botanical Journal. In 1817 he became director of the Botanical Garden of Angers where he remained until his death. His son *Emille Desvaux*, a very promising botanist, who elaborated the Grasses for the Flora Chilena, died a few years ago, at an early age.—*F. W. Wallroth*, a well known German botanist, the monographer of *Orobancheæ*.—*Targioni-Tozetti*, the distinguished Florentine botanist.—*W. G. Tilesius* (born in 1769), the naturalist of Krusenstern's voyage of exploration in 1803–1806!—*L. W. Dillwyn* (born in 1778), of Swansea, S. Wales.—*H. D. A. Ficinus*, of Dresden, author of a Flora of the neighborhood of Dresden and other works.—*M. Graves*, of Paris, a well known French botanist, but scarcely a botanical author.

To this list we may add the name of the venerable *Madame de Jussieu*, widow of *A. L. Jussieu*, and the mother of *Adrien*, who died in Paris

last year, at a very advanced age. The library and collections of this distinguished family are now dispersed. The herbaria we believe have gone to the *Jardin des Plantes*, but the library, so rich in botanical works, and especially in separate memoirs, gathered with such pains by at least three generations of botanists, is before this time widely dispersed by the hammer of the auctioneer.

An equally venerable name is now to be added, that of the distinguished algologist, *Mrs. Griffiths*, of Torquay, England, who died in the latter part of January, at the age of ninety. To her, almost half a century ago, Agardh dedicated the genus *Griffithsia*, a beautiful group of plants of the family she loved so well and so successfully cultivated even to the last, continuing her scientific correspondence with her friends down to the last months of her long and actively useful life.

We have also to announce the death, at the beginning of the present year, of *Dr. J. Forbes Royle* of London, author of Illustrations of the Botany of the Himalaya Mountains, and of various other works upon the botany, materia medica, and the industrial products of India. A. G.

6. *Notice of the occurrence of Green-gilled Oysters;* by W. J. Taylor. —A curious characteristic of the oysters of a locality in a sound on the eastern shore of Maryland may interest naturalists. The sound is on the Atlantic coast, and its principal outlet is Chincoteague Inlet. The oysters in question were taken from the latter named place where they had been planted to prepare them for the markets of New York and Philadelphia. They were planted about four years ago, at which time from some unknown cause numbers of them died. After a time they thrived greatly and were prized for their superior size and fine flavor.

After two years had elapsed, a peculiar green color was observed in the gills which continues; it is particularly intense and marked in the fall and winter when the mollusc is fat, and nearly disappears in the spring and summer. The color is only in the gills, the mantle being white; it may be termed a pea-green. By cooking it becomes darker; but it nearly disappears when the mollusc is placed in dilute alcohol.

The oysters are planted on a hard sandy bottom which has a slight coating of dark mud, in which grows a very small grass. The locality is within eight or nine miles of "Green Run" inlet, which is rapidly filling up with sand, which already prevents navigation. The tide ebbs and flows regularly about four inches. The same peculiar green color was noticed in oysters at this locality fourteen years ago, after which time it disappeared. The same color not so strongly marked has been observed near Chincoteague inlet.

7. *Humming Bird of the U. States*, (Ann. and Mag. Nat. Hist., [2], xx, 520).—Mr. Gould having returned from a visit to the United States, whither he had proceeded for the purpose of studying the habits and manners of the species of *Trochilus* frequenting that portion of the American continent, detailed some of the results of his observations.

Having arrived just prior to the period of the bird's migration from Mexico to the north, and having had ample opportunities for observing it in a state of nature, he noticed that its actions were very peculiar, and quite different from those of all other birds: the flight is performed with

a motion of the wings so rapid as to be almost imperceptible; indeed the muscular power of this little creature appears to be very great in every respect, as, independently of its rapid and sustained flight, it grasps the small twigs, flowers, &c., upon which it alights with great firmness, and if wounded clings to them with the utmost tenacity: it appears to be most active in the morning and evening, and to pass the middle of the day under the shade of the thick leafy branches. Occasionally it occurs in such numbers, that fifty or sixty may be seen on a single tree. When captured, it so speedily becomes tame, that it will feed from the hand or mouth within half an hour. Successful in keeping one alive during a long railway journey, in a gauze bag attached to his breast-button, for three days, during which it readily fed from a small bottle filled with a syrup of brown sugar and water, Mr. Gould determined to attempt the bringing of some living examples to England, in which he succeeded, but unhappily they did not long survive their arrival in London, and died on the second day: had they lived, it was his intention to have sent them to the Society's Gardens, where they would doubtless have been objects of great attraction. Mr. Gould added that he was certain that they might be readily brought to this country: that they would live in the gardens at least during the months of summer, and that the captains of any of the great steamers now voyaging between England and America would willingly render the assistance requisite to effect this desirable object.

8. *Leptosiagon*, Trask, nov. gen. (Proceedings of the California Academy of Natural Sciences, vol. i, p. 99, plate vi.)—Described by the author as a new genus of microscopic organisms referable to "the family of crustaceas, their form and inorganic structure, with their configuration seeming to warrant this, more properly perhaps than among the zoophytes or diatoms." They are said to be styliform, membrano-calcareous, with a central canal divided by transverse septa; the extremity armed with a moveable mandibular process. Eight species are described occupying "an extended geographical range, from Mexico to Japan." The figures of the plate are well executed; and to judge from them, these forms must have a remarkably close resemblance to the falcigerous setæ of some Annelides, *Nereis* for instance, both in form and structure. These setæ vary much in character in the different rings of the same worm, so that if our conjectures be true, all of these objects may belong to two or three species of Annelides. W. S.

IV. ASTRONOMY.

1. *Note on the Periodicity in the Sun's Spots;* by O. Reichenbach, (Communicated by letter dated Norristown, Pa., Jan. 15, 1858).—The frequency of "spots" as observed mainly by Mr. Schwabe of Dessau, embraces, in passing from maximum to minimum, a period of about 11 years. The causes of phenomena are far and near; there is often idle discussion about two claims. In suggesting a cause, I shall not indulge in fanciful details on the processes at the sun's surface, on the effects rather than causes, which practical men, consulting experience alone, conjecture, but which theory framers, as I confess to be, believe themselves unable to observe.

The period is about 11 years, the number of our year giving an ill-defined mark. A period by a primary cause oscillates by secondary causes. The revolution of Jupiter, the largest planet, is 11·86 years. There is affinity in these numbers. The maxima occurred in 1828, 1837 and 1848; another draws near; farther off, six periods correspond to six revolutions of Jupiter; but I may be mistaken, and by a constant acceleration seven periods may take place. When we try to combine the days of observation, the number of spots and of spotless days, we find the increase and decrease to be in a slow ratio before and after the maximum, and the decrease and increase in a rapid ratio before and after the minimum, a coincidence with the requirements of elliptic motion.

In 1828, 1837 and 1848 occurred the maxima. In 1827, 1839, 1851, 1862, Jupiter passes its aphelion. The first numbers coincide. The frequency of spots corresponds to the aphelion of Jupiter. The pressure at the perihelion, as my theory supposes, expands and increases the envelop; the aphelion condenses it, introducing a rapid alternation of precipitation and evaporation; the mass is thereby allowed to descend and meet in the equatorial regions, and the temperature is there increased. The numbers do not all coincide. But

(1.) Do the maxima by groups of spots correspond to the greatest area and darkness? No days were spotless in 1829, 1838 and 1839, all those years produced spots of largest dimensions.

(2.) There is a number of other planets; if we abstract from the far and slow, and the near and rapid small ones, the second central planet remains as the principal disturber. In 1827, Saturn was 10° (corresponding to the aphelion of Jupiter) in advance of its perihelion, and the number of spots was considerably less than in 1837 or 1848. In 1839 Saturn was 23° from its aphelion, advancing toward it. During the preceding years both planets advanced together towards their aphelions, and the greatest number of spots occurred before 1839. The reason of this anticipated maximum becomes obvious when we consult the position of the two aphelions. When the two planets draw near each other, the attractive force of the greater diminishes the spot-producing power of the smaller, the combined pressure on the sun is increased, the average distance diminished, the angular velocity of the greater augmented, whereas both planets advance in 1837 towards their aphelions in the latter half of the semi-orbits, but differ still about a quadrant in length, their spot-producing effect culminates, they exercise the least pressure, the least repulsion on the *interior* sun. In 1851 Saturn was 60° from its perihelion advancing towards it; beyond 48° its effect diminishes, the spot-producing effect of Jupiter still advancing to its aphelion. In 1862 Saturn will be 82° from its perihelion (in 1857–58 the time of the two perihelions pretty near coincides) advancing to its aphelion, and the maximum will be delayed till near that time. There is here a coincidence with the aphelion of Jupiter, but the maximum is in itself small. The next period, 1874, is brought down to 1872.

A relation between the "spots" and the oscillations of magnetism is suspected; it must exist. The planets must influence the magnetism; the effect from Jupiter on the earth must be large, as the latter twelve times revolving, passes at one time between the sun and that planet in its

perihelion and then in its aphelion. The earth is now pressed, now elated, its envelop now expanded, now condensed, between those two rotating balls, or magnets, or voltaic piles, or weights, or whatsoever they are called with reference to phenomena classed under those various denominations.

V. MISCELLANEOUS SCIENTIFIC INTELLIGENCE.

1. *Telestereoscope.*—Professor Helmholtz has described an instrument (Pogg. Ann., 1857, and Phil. Mag., Jan. 1858) which he calls a *Telestereoscope* (Telescopic stereoscope), the object of which is "to present, stereoscopically united, two pictures of a landscape corresponding to two points of view, whose distances considerably exceed the distance between the two eyes." The stereoscopic power of the eyes is small, because the distance between them is small. By the instrument it is widened, and the effect which a stereoscope produces in a picture of a landscape is thrown over the landscape itself. The instrument is made up of four mirrors and two eye-glasses. Two mirrors placed, alike, at an angle of 45°, one to the right and the other to the left, receive the rays of light from the landscape. These mirrors throw the rays horizontally towards one another to two oblique mirrors, which throw the rays through the eye-glasses to the eyes. In a window, place on either side, say three or four feet or the width of the window apart, a mirror, at the angle stated, to receive the rays from outside, the planes of the two mirrors converging of course to a point in the room. The mirrors will have the position of the half-opened shutters of the window. The rays from the scene outside on reaching them will be thrown parallel to the window, those of one mirror towards the other. Now by placing at the middle of the window two smaller mirrors meeting like the legs of a V, but at an angle of 90°, and facing in the room, the rays will be thrown into the room; and if these two mirrors are not too large or are properly placed, the rays will have just the distance apart required to pass into the eyes. A box or frame may enclose the mirrors, and a couple of lenses be inserted as eye-pieces, and the effect thereby be improved; though the lenses should have a focal length of thirty or forty inches. The mirrors should be made of the best plate glass. The size may be much larger than the breadth of a window; although not to any very great advantage.

To see near objects in the telestereoscope, the reflectors must be turned round their vertical axes so that the angle between their surfaces and the long edge of the box is somewhat greater than 45°. The objects then appear greatly reduced in size, but in surprisingly prominent relief. When the large mirrors only are turned, the small ones being left at the angle of 45°, an exaggerated relief is obtained. If the dimensions in the direction of the depth of the field of view to those on the surface are to retain their right relations, the large mirrors must always remain parallel to the small ones. The aspects of near objects, particularly of the human figure, are strikingly beautiful in the telestereoscope. The impression differs from the reduction produced by concave glasses, in the circumstance that it is not reduced pictures that the observer imagines he sees, but actually reduced bodies.

Magnifying power may easily be connected with the telestereoscope: it is only necessary to place a double opera-glass between the eyes of the observer and the small reflectors; it is still preferable for the field of view, to separate the eye-glass from the object-glass of the instrument, and so fix them in the telestereoscope that the light at each side first strike the large mirror, then the object-glass, then the small reflector, and finally the eye-glass; so that in this arrangement the optic axis of the telescope itself is broken at a right angle. The greater the magnifying power, the greater of course must be the perfection of the plane reflectors, but then it is not necessary to choose them larger than the object-glass of the telescope.

These views, at the same time telescopic and stereoscopic, also exceed to an extraordinary degree the common image of the telescope in vividness. In the simple telescopic images, difference of distance disappears totally: the objects look exactly as if they were painted on a plane surface. By the ordinary combination of the two Galileo's telescopes, the appearance of relief for nearer objects is in some degree obtained; and hence it is that a double opera-glass gives a much livelier impression of relief than a single one. But in the usual construction of the instrument the relief is false: the objects appear as if they were squeezed together in the direction of depth. In the case of human faces, on which, for the most part, opera-glasses are directed, this is very striking. When they are regarded from the front, they appear much flatter than they really are, and when looked at in profile, they appear too narrow and sharp. In both cases the expression of the countenance is essentially altered.

When a double opera-glass is turned round and the observer looks through the object-glass, the deep dimensions of objects are magnified out of proportion. While, therefore, through a simple telescope all objects appear as paintings, through a double opera-glass, complete objects are seen as *bas-reliefs*, while by reversing the opera-glass, objects appear in high relief.

2. *Inquiries into the Quantity of Air inspired throughout the Day and Night, and under the influence of Exercise, Food, Medicine, Temperature,* &c., by Edward Smith, M.D., (Proc. Roy. Soc., L. E. and D. Phil. Mag., xiv, p. 546).—This communication consists of three parts and contains the results of 1200 series of observations. The author was himself the subject of all the investigations. He is thirty-eight years of age, six feet in height, healthy and strong, and with a vital capacity of the lungs of 280 cubic inches.

The paper concludes with a summary of the principal results obtained and a series of deductions, applicable especially to the solution or elucidation of hygienic questions. From the former the following facts are extracted:—

The total quantity of air inspired in 24 hours (allowance being made for intervals amounting altogether to 40 minutes, during which it was not recorded) was 711,060 cub. ins.; or an average of 29,627 cub. ins. per hour and 493·6 per minute. The quantity was much less during the night than during the day. There was an increase as the morning advanced and a decrease at about $8^h\ 30^m$ P. M., but most suddenly at about 11 P. M. During the day the quantity increased immediately after a meal,

and then subsided before the next meal; but in every instance it rose again immediately before a meal. The rate of frequency of respiration generally corresponded with the quantity, but the extremes of the day and night rates were greater. The period of greatest parallelism was between tea and supper. An increase was occasioned by one meal only, namely breakfast. The average depth of respiration was 26·5 cub. ins., with a minimum of 18·1 cub. ins. in the night, and a maximum of 32·2 cub. ins. at $1^h\ 30^m$ P. M. The mean rate of the pulse was 76 per minute, the minimum at $3^h\ 30^m$ A. M., the maximum at $8^h\ 45^m$ A. M.; the difference being more than one-third of the minimum rate.

Sleep came on in two of the series of continuous observations, and the time of its occurrence was also that of the lowest quantities of air inspired.

The amount of breathing was greater in the standing than in the sitting posture, and greater sitting than lying. It was increased by riding on horseback, according to the pace, also by riding in or upon an omnibus. In railway travelling the increase was greater in a second- than in a first-class carriage, and greatest in the third-class and on the engine. An increase was also produced by rowing, swimming, walking, running, carrying weights, ascending and descending steps, and the labor of the tread-wheel; and in several of these cases the rate of increase was determined for different degrees of exertion used. Reading aloud and singing, and the movement recommended by Dr. Hall for restoring suspended respiration, increased the quantity; bending forwards whilst sitting, lessened it.

The quantity of inspired air was increased by exposure to the heat and light of the sun, and lessened in darkness. Increase and decrease of artificial heat produced corresponding effects; and the depth of respiration was greatly increased by great heat. An increase in quantity was caused also by cold bathing, and sponging, and the cold shower-bath; by breakfast, dinner, and tea—when tea actually was taken, but when coffee was substituted there was a decrease. Supper of bread and milk also caused a decrease. Milk by itself or with suet caused an increase.

An increase was obtained with the following articles of diet, viz.: eggs, beef-steak, jelly, white bread (home-made), oatmeal, potatoes, sugar, tea, rum (1 oz). The following caused a decrease, viz.: butter, fat of beef, olive oil, cod-liver oil, arrow-root, brandy (1 oz. to $1\frac{3}{4}$ oz.), and kirchenwasser. Ether ($\frac{1}{2}$ drachm) increased the quantity and depth of inspiration. A decrease in quantity was caused by sp. ammon. co. ($\overline{3}$iss), sp. ammon. fœt. ($\overline{3}$iss), tincture of opium (20 ♏), morphia ($\frac{1}{6}$ and $\frac{1}{8}$ gr.), tartarized antimony ($\frac{1}{4}$ gr.), and chlorid of sodium.

Carbonate of ammonia (15 grains) caused a small increase at first and then a small decrease; febrifuge medicines had a like effect. Chloroform 25 ♏ and $\overline{3}$ss), by the stomach, varied the quantity from an average increase of 28 cub. ins. to an average decrease of 20 cub. ins. per minute; with a maximum increase of 63 cub. ins. per minute. Chloric ether ($\overline{3}$ss) also varied the quantity, but there was an average increase of 17 cub. ins. per minute, and of 1·8 per minute, in the rate; whilst the pulse fell on the average 1·7 per min. Chloroform, by inhalation (to just short of unconsciousness), lowered the quantity a little during the inhalation, and

more so afterwards. The rate was unchanged, but the pulse fell, on an average, 1·7 per min. Amylene similarly administered and to the same degree, increased the quantity during inhalation 60 cub. ins. per min., but afterwards decreased it to 100 cub. ins. per min. less than during the inhalation. The rate of respiration was unchanged: the pulse fell 6 per min. at the end of the observation.

Digitalis (infusion ℥i) varied the quantity, increasing it at first and then decreasing it. The rate of inspiration was unaffected, whilst that of pulsation somewhat increased.

The paper is accompanied by tables of numerical statements, and by diagrams exhibiting the results in a series of curves.

3. *Fluorescence.*—Prof. J. W. Mallet states in a letter to one of the editors of this Journal (dated Tuscaloosa, Ala., Jan. 29) that an old solution of oil of orange-flowers (Oleum Neroli) in alcohol—one part of the former to twelve or fifteen of the latter—fluoresces strongly with a beautiful pale purplish light. The solution was made some six or seven years ago, and did not exhibit this phenomenon at first.

4. *A System of Instruction in the Practical Use of the Blowpipe, being a graduated course of analysis for the use of Students and all those engaged in the examination of metallic combinations.* 268 pp., 12mo. New York, 1858. H. Bailliere.—The use of the blowpipe has been so thoroughly perfected by Berzelius and Plattner that now-a-days it is hardly possible to produce an original treatise on this subject. Those who have hitherto undertaken to prepare blowpipe manuals, have wisely followed the accurate observations of these masters, and have reproduced them in a more or less altered form and arrangement, to suit the convenience of students. The book before us is acknowledged to be chiefly a copy, but it is eminently and unfortunately original.

The work is due, as appears from the publisher's advertisement, to Prof. J. Milton Sanders of Cincinnati, Ohio, though a modest S. appended to the Preface is all of the name the present volume contains. We had occasion recently to criticise a publication issued over the same name; and we could wish that now we had only to commend. But we should not be just to good English or good science if we were so to treat it.

Besides much incorrect use of plain English, we find German idioms strangely intruded on the language of the laboratory, and also misunderstood. He says, "If insoluble substances are fused with others for the purpose of causing a combination which is soluble in water and acid, the operation is called *unclosing*" (aufschliessen?). Again, "If we detonate (as it is termed by the German chemists) the sulphide of antimony or the sulphide of arsenic with nitrate of potash, we get the nitrate of antimony or *nitrate of arsenic*." We are not aware that either our own or the Latin language is indebted to the Germans for the word *detonate*, and moreover we do not see any propriety in its use in that place. The author may have meant to say *deflagrate*, though this would not be a term from the German chemists. The science of the passage is its most extraordinary feature; for we have here announced for the first time in the history of chemistry, the existence of a *basic oxyd of arsenic and its nitrate*—a fact not even mentioned in the 4th American edition of Gregory's Chemistry, edited by Prof. Sanders himself!

The above may be enough to exhibit both the literary and scientific merits of the work. We would not however do the author injustice, and therefore make a few other citations. The italics beyond are ours.

Page 160 we read: "Arsenic acid (AsO^5) is a white mass which readily absorbs moisture and dissolves. It will not volatilize at a low red heat, *nor will it decompose.* Exposed to a strong heat it is decomposed, yielding oxygen, and passing into arsenious acid." Under arsenious acid we are told that "Upon charcoal it *instantly* volatilizes, and *when heated* the characteristic garlic smell is perceived."

Of silver is said (p. 163), "it is *not* oxydizable, *neither* at common temperatures *nor* at those which are considerably higher." The merest tyro in chemistry will henceforth have an infallible means of recognizing this useful metal. On page 59, in describing the behavior of silver on charcoal before the blowpipe, the language of Plattner and Scheerer being nearly followed, and also on page 264, where Blanford's account of the reactions of native silver is copied—the well known red deposit of oxyd of silver formed when the metal or its oxyds are strongly heated on charcoal is of course duly noticed; but in the chapter on *Special Reactions*, which appears to be the most original part of the work, in giving the general characters of his "ninth group" of metals, viz., copper, silver and gold, Prof. S. states that: "In the reduction of the oxyd of this group no sublimate is visible on charcoal."

Platinum is repeatedly said to be infusible. We are however in the habit of showing to our classes the fusion of a fine wire of this metal in the flame of the mouth blowpipe in accordance with the observations of Fiedler, Plattner and others.

According to the author, boracic acid bleaches brazil-wood-paper, but nothing is said of the action of sulphurous acid, the latter having this bleaching effect while the former has not. We also learn that phosphoric acid tinges it yellow in the same manner as hydrofluoric acid.

The blowpipe is concisely described in the following language. "It is generally made *in the form of a tube* bent at a right angle, but without a sharp corner. The largest one is about seven inches long, and the smallest about two inches." This of course refers to the common blowpipe; but the hand blowpipe used for chemical purposes does not seem to be "made in the form of a tube" if we rightly understand the following description. It "is composed of the following parts: (fig. 1) A is a little reservoir made *air-tight* by grinding the part B into it."

After 178 pages of the proper treatise on the blowpipe, the author finishes his labors by copying bodily, typographical errors included, about 90 pages from Blanford on the Behavior of Minerals before the Blowpipe, which his preface thus acknowledges; we quote the paragraph as an example of his style: "In Part Third of this work, commencing at page 109, the student will find a sufficiently explicit description of the blowpipe reactions of those principal substances that would be likely to come *beneath* his attention. The following tabular statement of those reactions—which we take from Scheerer and Blanford's excellent little work upon the blowpipe—will be of great benefit, as a *vehicle for consultation*, when the want of time—or during the hurry of an examination—precludes the attentive perusal of the more lengthy description in the text."

5. *Lectures on Roman Husbandry*—delivered before the University of Oxford, comprehending such an account of the System of Agriculture, the Treatment of Domestic Animals, the Horticulture, etc. pursued in ancient times, as may be collected from the Scriptores Rei Rusticæ, the Georgics of Virgil, and other classical authorities, with notices of the plants mentioned in Columella and Virgil; by Professor CHARLES DAUBENY, M.D., F.R.S., etc., Professor of Botany and Rural Economy in the University of Oxford. 328 pp., 8vo. Oxford and London, 1857.—The scientific and classical world are under equal obligations to the learned author for his valuable and attractive work on the condition of agriculture and horticulture, and the breeding of domestic animals, in the most flourishing period of the Roman power. The author alludes in his preface to his indebtedness to the earlier treatise of the Rev. Mr. Dickson on the "Husbandry of the Ancients," published in 1788, but states that he has embraced a wider range of topics, adding to the subject of tillage that of the culture of the vineyard and orchard, the treatment of domestic animals of all kinds, the cultivation of the garden and other collateral topics Dr. Daubeny has brought to the task a familiar acquaintance with classical learning as well as with the sciences pertaining to the subject. As a chemist and botanist and also a man of general science he has long been known. It is impossible, within the limits of a brief notice, to present an analysis of a work which is itself an analysis of the ancient authors on the subjects referred to. The impression left on the mind of the reader is, that of an interesting and instructive review of antiquity; we travel along pleasantly with the author through his learned and agreeable volume.

The work is illustrated by a plan of Pliny's Laurentian villa and grounds, another of a Villa Urbana Rustica and Fructuaria according to Columella, of a Garden and Portico at Pompeii, pictures of agricultural operations from Egyptian monuments, ancient Greek agricultural implements, plan of an Egyptian garden, and drawings of plants mentioned by ancient authors. B. S.

6. *Medical Lexicon: A Dictionary of Medical Science, &c.;* by ROBERT DUNGLISON, M.D., LL.D., revised and very largely corrected. Philadelphia: Blanchard & Lea. 1857. 8vo, pp. 992.—This accomplished and learned author here presents us with a thoroughly revised edition of his *Lexicon* of medical terms. It is prepared with great care and in the widest and most catholic spirit. The literary and the mechanical execution of the work are remarkably accurate and satisfactory. Good lexicons and encyclopedic works generally, are the most labor-saving contrivances which literary men enjoy; and the labor which is required to produce them in the perfect manner of this example is something appalling to contemplate. The author tells us in his preface that he has added about six thousand terms and subjects to this edition which before was considered universally as the best work of the kind in any language.

7. *Cosmos.*—Humboldt, in a letter to the German Association of Naturalists and Physicians, recently published, announces that a new volume of the Cosmos (the first *Abtheilung* of the fourth and last *Band*) is almost ready for publication. It will present, as a counterpart to the third volume on Uranologie, an introduction to the special presentation of Terres-

trial phenomena. The contents are stated as follows. Book I: Size, Shape and Thickness of the Earth, Internal Heat, Magnetic Activity of the Earth, Intensity, Inclination, Declination, Magnetic Equator, Four Points of the Greatest Intensity, Curve of the Weakest Intensity, Extraordinary Disturbances, Magnetic Storms, Polar Light. Book II: Reaction of the Interior of the Earth upon the Surface, Earthquake, Thermal Springs, Volcanoes, Naphtha Springs, Volcanic Phenomena.

The second part of the fourth volume, which will complete the whole work, will contain, Classification of Mountains and Strata according to their different modes of origin, Conformation of Plains, the Sea and its Currents, the Atmosphere, Meteorological reflections, Isothermal Lines, Organic Life, Geography of Plants and Animals.

8. *Graham's Chemistry*, Vol. II.*—This long expected volume is at last published, forming volume xiii of Mr. Bailliere's 'Library of Illustrated Scientific Works.' It is a very acceptable addition to the library of standard books of every chemical student. Mr. Watts, well known as the translator of the Cavendish Society edition of Gmelin's Chemistry—has made in the Supplement an able resumé of the progress of the science since the publication of the first volume. It is plain from the number and importance of the topics there discussed that great progress has been made in the interval both in chemical physics and in general inorganic chemistry. The best thing the enterprising publisher can now do is as soon as possible to reprint the whole work and incorporate in their proper places the various topics forming the Supplement of 320 pages. But as it is, no reader of English works on this science can afford to be without this edition of Prof. Graham's Elements. A mention of some of the topics discussed will justify this assertion. We find the new methods of Volumetric Analyses detailed, with a description of Bunsen's General Method, the Mechanical Equivalent of Heat, the Mechanical and Chemical Measure of the effects of the Electric Current, Pasteur's observations on the remarkable relations between Crystalline form and Molecular rotary power. The modern views of the constitution and classification of Chemical Compounds are explained at considerable length chiefly according to Gerhardt's Unitary System. The work is beautifully printed, and, as far as we have examined it, praiseworthy in its freedom from typographical errors.

9. *Life of Dr. E. K. Kane;* by Dr. Wm. Elder. Philadelphia, 1858. Childs & Petersen. 8vo, pp. 416.—Every thing connected with the romantic and self-sacrificing life of Dr. Kane is read with avidity by people of all conditions. Dr. Elder's memoir is a glowing eulogy of his hero. The most valuable portions of it are the numerous extracts from the letters and manuscripts of Dr. Kane, picturing his various wanderings in Africa, Asia and Europe.

10. *American Association for the Advancement of Science.*—The next meeting of the Association will be held at Baltimore, commencing with the last Wednesday in April. Prof. Jeffries Wyman of Cambridge is President elect for the coming year.

* Elements of Chemistry, including the Application of the Science to the Arts, by Thos. Graham, F.R.S., L. & E. 2d edition, edited by Henry Watts, B.A., F.C.S. New York, Chas. E. Bailliere, 1857. 8vo, pp. 804.

O. Reichenbach: Einige Gedanken eines Nichtgelehrten bei Lesung des Kosmos. 138 pp. 12mo. Philadelphia, 1857.

Boston Journal of Natural History, Vol. VI, No. IV. Contents.—Art. XXV, New Species of Fossil Plants from the Anthracite and Bituminous Coal fields of Pennsylvania, by Leo Lesquereux, with introductory observations, by H. D. Rogers.—Art. XXVI, Observations on the Development of *Anableps Gronovii*, by Jeffries Wyman.—Art. XXVII, On the Crustacea and Echinodermata of the Pacific shores of North America, by W. Stimpson.—Art. XXVIII, A list of the Fishes collected in California by Mr. E. Samuels, with descriptions of new species, by C. Girard.

Journal of the Academy of Natural Sciences of Philadelphia. New Series, Vol. III, Part IV.—Art. XIX, Descriptions of Exotic Genera and Species of the Family Unionidæ, with plates 21 to 33, by I. Lea.—Art. XX, Observations on a group of Cretaceous Fossil shells, found in Tippah Co., Miss., with descriptions of fifty-six new species, with plates 34, 35, by T. A. Conrad.—Art XXI, On the Caducibranchiate Urodele Batrachians, by E. Hallowell.—Art. XXII, On Trigonophrys rugiceps, and plate 36, by E. Hallowell.

Proceedings Acad. Nat. Sci. Philad., 1857.—p. 101, Six new species of Fresh-water and Land shells of Texas; *I. Lea.*—p. 102, Examination of a Nickel Meteorite from Mississippi; *W. J. Taylor*—p. 109, Notes explanatory of a Map and Section illustrating the Geology of the Nebraska Territory: *F. V. Hayden.*—p. 117, Descriptions of New Fossils from the Nebraska Tertiary and Cretaceous; *Meek* and *Hayden.*—p. 148, On the Larva of Thyreus Abbottii; *J. P. Kirtland.*—p. 149, 150, Bone and Coprolite from the New Red Sandstone of Pennsylvania; *J. Leidy*—p. 150, The Insectivorous mammal of the New Red of N. Carolina, named *Dromatherium sylvestre* by Emmons, is closely allied to the Spalacotherium of Owen from the English Purbeck beds of the Oolitic formation; *J. Leidy.*—Change of the generic name of fossil fishes *Mikolepis* to *Eurylepis*; *J. S. Newberry.*—p 151, Notes on the Geology of the Mauvaises Terres, Nebraska; *F. V. Hayden.*—p. 159, Prodromus descriptionis Animalium evertebratorum, &c., Annelides; *W. Stimpson.*—p. 165, Descriptions of two new genera of shells, one including a species near Anodonta from the Sacramento, the other an Eocene fossil hitherto referred to Rostellaria, and named *Calyptraphorus* (*C. velatus*, being Rost. velatus, of Conrad, Tert. Foss., p. 38, pl. 15, f. 4); *T. A. Conrad*—p. 166, Rectification of some generic names of U. S. Tertiary fossils; *T. A. Conrad*—A new *Mycites* from the Black shale of the New Red Sandstone of Pennsylvania; *T. A. Conrad.*—p. 167, A new genus, *Mytilopis*, related to Mytilus; *T. A. Conrad*—p. 167, Notice of some remains of extinct Fishes (Cretaceous, Tertiary and New Red); *J. Leidy.*—p. 168, Examination of Enargite; *W. J Taylor.*—p. 169, Descriptions of 27 new species of Uniones from Georgia; *I. Lea.*—p. 173, Fish scale from Red Sandstone formation of Gwynned, Pa., probably identical with *Radiolepis speciosus*, Emmons, of N. Carolina; *I. Lea*—p 174, On three new species of Vespertilionidæ; *John LeConte.*—Rectification of the references of certain of the Extinct Mammalian Genera of Nebraska; *J. Leidy.*—p. 176, Dentition of Mosasaurus; *J. Leidy*—p. 178, Note on Insect wax of China.—The Atlantic fishes, *Exocetus acutus*, *Pristipoma Rodo*, *Ephippus Faber*, found at Panama in the Pacific.—p. 179, Observations on the Wild Turkey, Gallopava sylvestris; *J. LeConte.*—p. 181, 195, New Reptiles collected in Wilkes's Expl. Exp; *C. Girard*—p. 183, Notes on American Land Shells; *W. G. Binney.*—p. 200, Notice of new genera and species of Marine and Freshwater Fishes from Western North America; *C. Girard.*—A new Cyprelus from Puget Sound; *C. B. R. Kennerly*—Notes on Gordius, larves of an Œstrus in a pouched rat, a new animalcule; *J. Leidy.* p. 205.—p. 206, On the experiment of introducing the Camel into America; *Dr. Hammond.*—p. 213, On N. American species of Archibuteo and Lanius and description of a new Toucan; *J. Cassin.*—p. 215, New North American Reptiles; *E. Hallowell.*—p. 216, Prodromus Descriptionis An. everteb. &c, Ringgold and Rodgers' North Pacific Expedition,—Species of Crustacea (*Maioid*); *W. Stimpson.*—Annual Reports.

APPENDIX.

1. *On Permian Strata in Kansas Territory;* by Prof. G. C. SWALLOW. (From a letter to J. D. DANA, dated Columbia, Missouri, Feb. 16, 1858.)

I have just finished the examination of a collection of fossils from Kansas Territory, made by Maj. Hawn, who was formerly connected with our Survey. The larger part of the collection is from the Upper Coal Measures; but by far the most interesting part can not be referred to the Carboniferous, or to any other formation heretofore known to exist in the West.

From the beds in doubt there was but one known Carboniferous species, *Terebratula subtilita* of Hall. It is quite certain they are not Cretaceous. After a somewhat careful comparison with the Permian fossils of Russia, we are satisfied that they are *Permian.*

Three out of the four species of corals, are without doubt Permian.

Thamnicus dubius, King, is certainly in our collection.

Thamnicus. Species undetermined, but identical with a Permian specimen figured in the Geol. Trans., 2d Series, vol. iii, pl. XII, fig. 7.

Fenestella retiformis, King. Our specimens are identical with the Russian species referred doubtfully to this, by Mr. Lonsdale, Geol. Russia, p. 630.

Schizodus Rossicus, Vern., Geol. Russ. pl. XIX, figs. 7 and 8. We have many specimens of this Permian species. Both varieties and the intermediate forms are represented.

Avicula antiqua. Geol. Russ., pl. XX, fig. 13.

Productus horrescens, Vern., Geol. Russ. pl. XVIII, fig. 1. Our collection contains specimens which are more nearly allied to these than to any other known species.

We also have species which are very nearly if not quite identical with *Murchisonia subangulata,* Vern., *Mytilus Pallasi,* Vern., *Solemya biarmica,* Vern., *Ostodemia Kutorgana,* Vern., of the Permian in Russia and *Cardinia Listeri* of the English Lias. We also have one or two species of *Monotis,* a genus seldom, if ever, extending down into the Carboniferous.

I can but feel that the above is sufficient to justify us in the decision that they are *Permian.* I know of no other formation in the country, whose fossils would give so large a proportion of species identical and analogous with those of any one locality in Europe.

We have as yet compared them with none but the Russian species by Verneuil. When the examination is completed I will give you the result more in detail.

2. *New Determination of the Sun's Parallax.*—In a letter to the Hon. I. Toucey, Secretary of the Navy, dated Feb. 18, 1858, Prof. J. M. Gilliss communicates as one result of the observations on Venus and Mars made by the U. S. Astronomical Expedition to Chili in 1849–1852, compared with simultaneous observations in the Northern hemisphere, that the Sun's Equatorial Horizontal Parallax is 8″·4950, or 0″·0762 less than the value commonly adopted; corresponding to a mean distance of the Sun from the earth of 96,160,000 statute miles.